Materials & Methods

Selection & use of

metals, nonmetallics, parts, finishes,

in product design & manufacture

REDUCE COSTS, IMPROVE QUALITY THROUGH BETTER MATERIALS SELECTION

SPECIAL ARTICLE

MAY 8 - 1956

DESIGN ENGINEERING SHOW ISSUE

PREVIEW OF EXPOSITION | CONFERENCE MAY 1956

FIFTY CENTS

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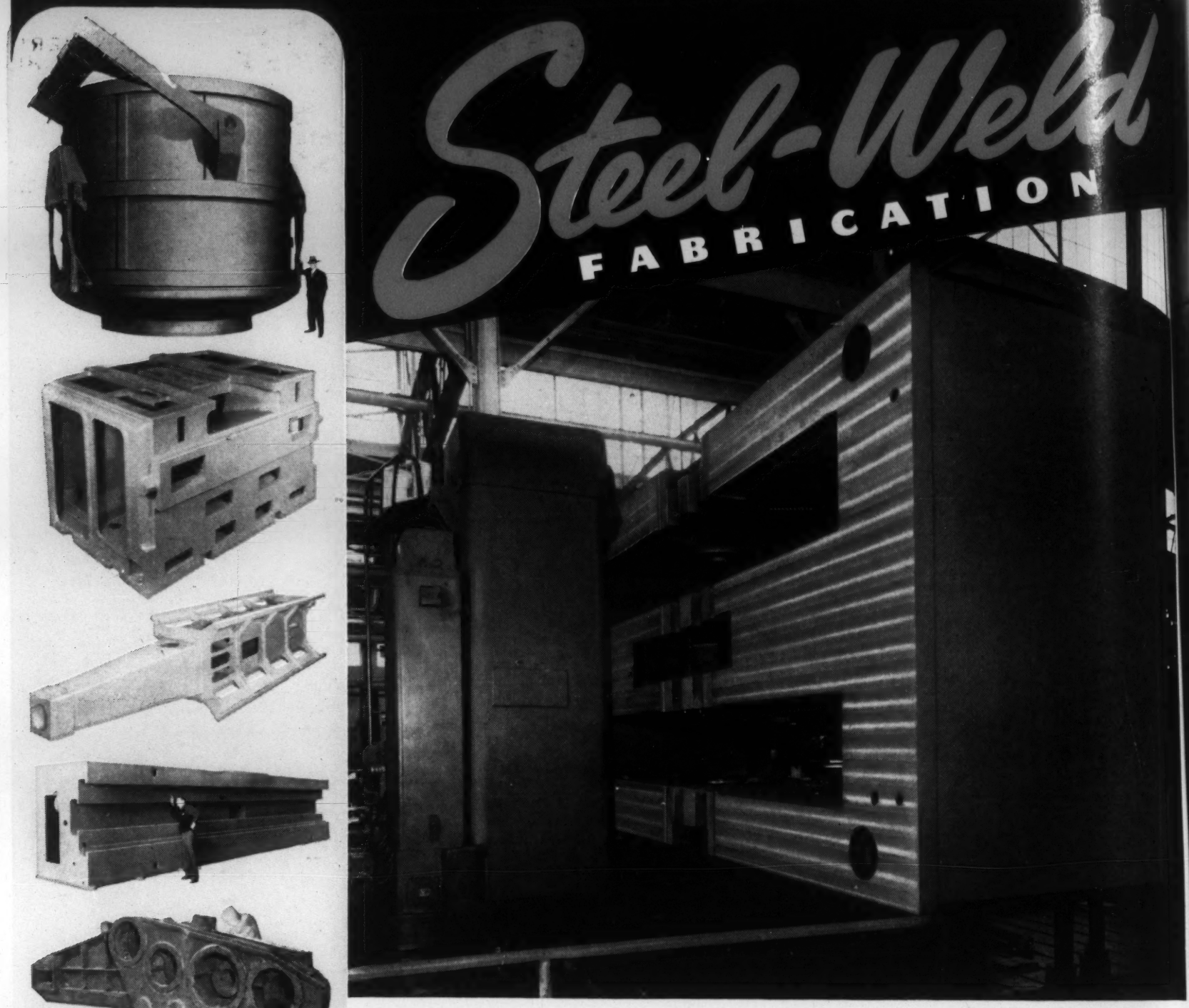

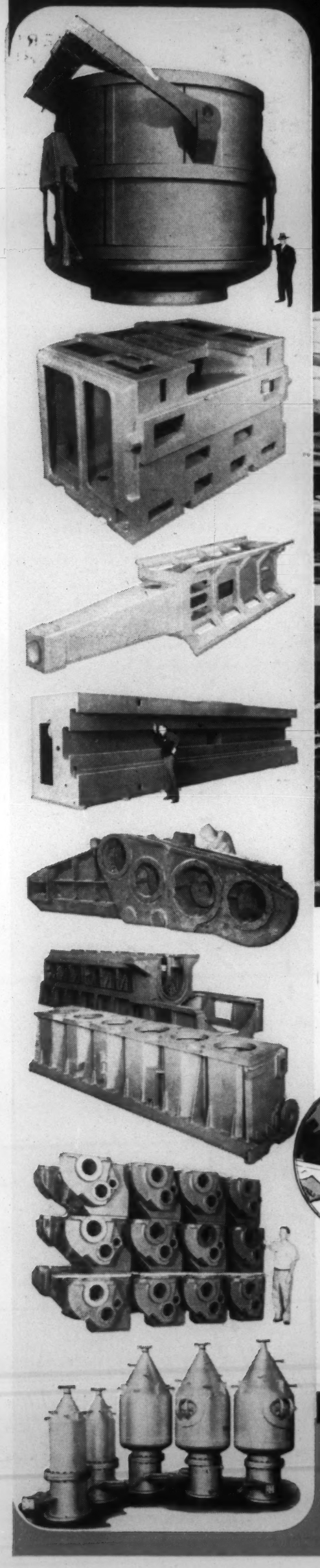

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MAY 8 - 1956
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Selection & use of

metals, nonmetallics, parts, finishes

in product design & manufacture

MAY 1956 **VOL. 43, NO. 5**

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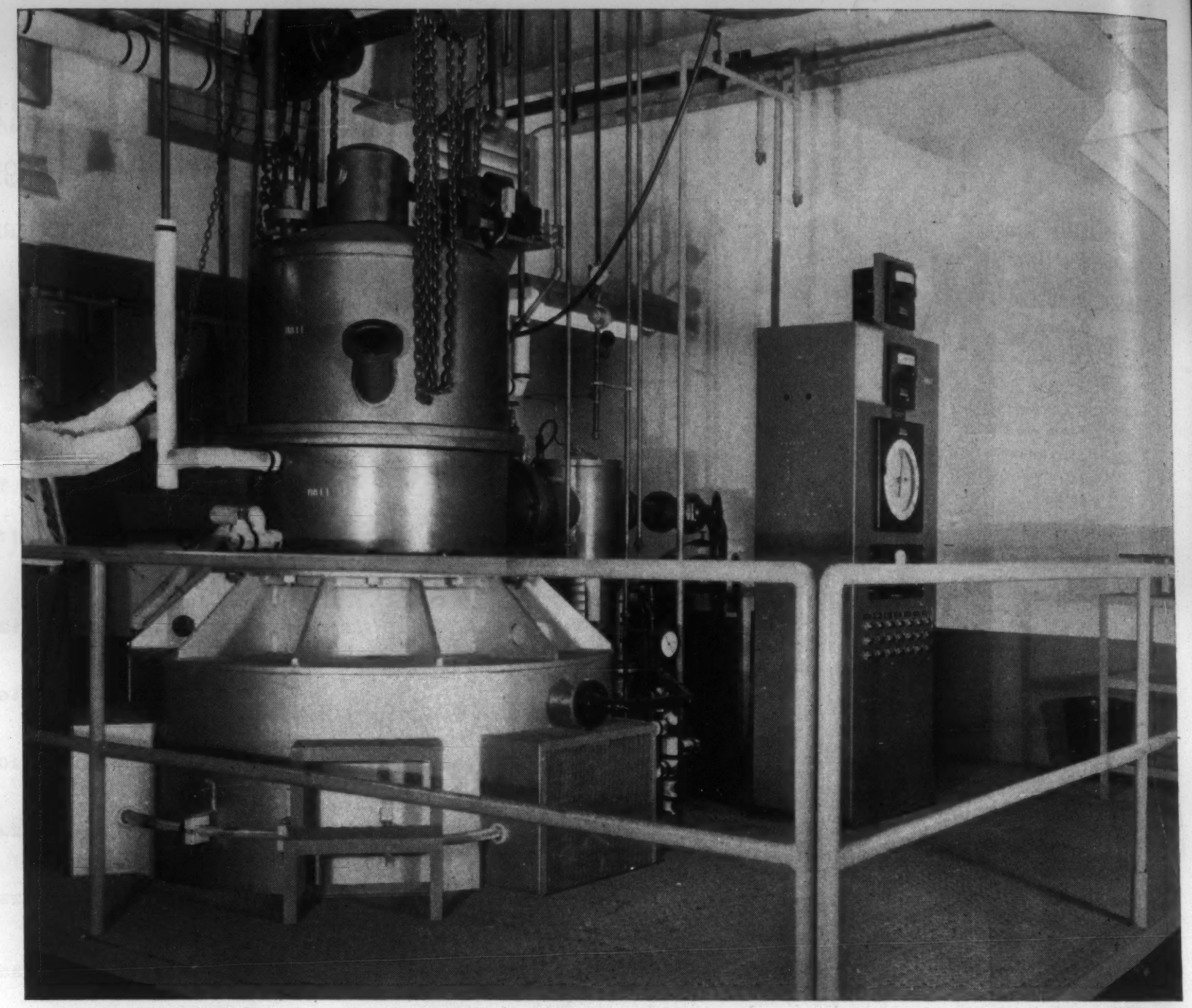

Costs and rejections fall substantially, thanks to this new degassing and annealing furnace with its Inconel nickel-chromium alloy retort. Using no gas atmosphere, the unit removes danger of explosions, yet its degassing capacity speeds output. Installed in plant of Raytheon Mfg. Co. Developed by High Vacuum Equipment Corp., Hingham, Mass.

Inconel retort gives safe service in high-vacuum heat treatment

HERE'S ONE OF THE FIRST large-scale vacuum heat-treating installations in the electronic field. This unit degasses steel rings for use in special-purpose power tubes.

It develops such high temperature and vacuum together that the steel readily releases impurities. Particularly gases which can spell failure if emitted during tube operation.

INCONEL the answer

Holding a vacuum of 5×10^{-4} mm Hg for 6 to 8 hours at 1850° F calls for a vessel combining great strength and heat resistance. Operators seal the work in a retort fabricated entirely of Inconel* nickel-chromium alloy.

This alloy resists damage by oxidation and carburization. It combats hydrogen embrittlement, scaling and other corrosive effects. Structurally and mechanically, Inconel nickel-chromium alloy is stable. It provides high load-carrying capacity and creep strength. In addition, it withstands thermal shock without spalling.

Readily fabricated

Measuring 48″ in length with an inside diameter of 36″, and made of plate 3/8″ thick, this retort shows how well Inconel nickel-chromium alloy responds to fabrication. You can form, machine and weld Inconel. And it's available in all commercial wrought forms.

Write for the useful, free booklet, "Keep Operating Costs Down as Temperatures Go Up." Inconel may save you money, so write for your copy now.

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Materials Outlook

COPPER PLATED STAINLESS STEEL WIRE is now in commercial production. A single strand machine electrolytically plates copper on stainless steel wire of 3/16- to 5/8-in. dia. Plate thickness normally varies from 0.1 to 0.2 mil. Wire is used for applications requiring high temperature corrosion resistance.

OVER 375 EPOXIDES, starting materials for making epoxy resins, have been produced from high purity peracetic acid. The reactivity of the pure acid gives it a broad potential for use in adhesives, plastics and coatings.

TITANIUM NEWS: 1) A Canadian company is producing titanium and titanium alloy powder from pigment grade titanium dioxide. Powder is −20+200 mesh and can be readily pressed into pellets. The process is particularly adapted to alloy production since powders can be mixed in desired proportions before reduction. When produced in quantity, powder might sell for $2.50 per lb. 2) Because commercal titanium yield strengths range from 70,000 to 120,000 psi, predicting springback in forming continues to be one of the biggest problems in titanium fabrication. One solution recently suggested for this problem is to divide titanium batches into 5000 psi brackets. Tools can then be designed within the limitations of each strength bracket. 3) A new titanium plant with 7500 ton per yr capacity is scheduled to go into production this month. Sodium reduction process will be used, and sponge will run to 40% of −20 mesh with a density of 55 lb per cu ft.

POLYETHYLENE CONTAINERS will be used to handle radioactive materials. The containers made of seamless cast polyethylene tubing can be decontaminated after use to 99% cleanliness in one cleaning operation.

LIGHT GAGE STEEL PRODUCTS accounted for 69% of the record 85 million tons of finished steel shipped during 1955. Sheet and strip made up 55% of these light gage products, cold rolled sheets 26%. Records were also set in shipments of galvanized sheets, hot rolled sheets and electrolytic tin plate.

ALUMINUM'S RESISTANCE TO WATER CORROSION is greatly increased by a small addition of nickel. An 1100 aluminum containing approximately 1% nickel showed penetration rates in static distilled water of 1, 1.5, 3 and 9 mils per year at 480, 550, 595 and 660 F respectively.

ZIRCONIUM ALLOYS can now be produced to meet exacting specifications. The difficulty of adding and distributing alloys during the melting cycle was solved by compressing the alloys, such as tin, nickel or chromium, into pills and feeding them into the arc furnace

Materials Outlook

during melting. Alloys are mixed by stirring the molten zirconium with a magnetic field. The resulting ingot is then remelted to improve distribution of the alloys.

NATURAL RUBBER DEVELOPMENTS in Europe: 1) Heveaplus, a combination of Hevea rubber and polymers or resins, is said to be non-breakable and capable of being fabricated into rigid tubing. Hard rubbers in the Heveaplus range can be white, brightly colored or transparent. 2) Rubber hydrochloride, obtained by adding hydrochloric acid to natural rubber, can be stretched into a plastic-type rubber thread which may be useful in seat covers and special fabrics. 3) Use of natural rubber in extremely cold climates appears more feasible now that it has been found that thiol acids will inhibit the crystallization of natural rubber at low temperatures. Less than 1% of thiols slows down the crystallization process 100 times. 4) A reinforced rubber that requires no carbon black can be made from equal parts of cyclized rubber and natural rubber. Products of low density with high modulus and hardness can be produced from the material.

METALS NOW IN DOMESTIC SHORT SUPPLY may become increasingly less critical because of a new refining method. Complex ores which cannot be beneficiated by conventional means are bombarded with an electron stream, generating temperatures up to 18,000 F and vaporizing the metals in the ore. The vapors are collected, and the metals can then be separated by ordinary chemical methods. Such vitals metals as uranium, beryllium, lithium and manganese can be obtained by this method.

PAINTS, PLASTICS AND WATER RESISTANT CELLOPHANE are among the products that can be manufactured from itaconic acid-derived esters recently made available to industry. Two such esters, diallyl and monoallyl itaconate, have been used experimentally as plasticizers in the preparation of plastisols.

SILVER CONTACT SURFACES on aluminum, achieved by a new process, may solve the problem of connecting aluminum electrical conductors to copper alloy materials. After careful cleaning of aluminum surface, silver coatings are applied by controlled deposition of special oxides, replacement of oxides with an intermediate deposition of zinc, and displacement of the zinc by silver. Currently used on aluminum bus bars, the silver surface has eliminated bridging of oxides or other surface impurities that frequently occurs during electroplating.

AN IRRADIATED POLYETHYLENE INSULATION can withstand temperatures of 300 F, compared to 200 F for the conventional product and 250 F for Ziegler process and previous irradiated polyethylene. Now in commercial production, the insulation is made by extruding polyethylene on wire and exposing it to beta rays.

Materials BRIEFS

Dirty Trick

Certain combinations of mercury, zinc and cadmium cause viruses to shed their tails. Without a tail the average virus loses the ability to attach itself to a host and can neither kill the host nor reproduce.

Man Takes Over

Usage of tree-grown rubber in the U. S. during 1956 is expected to decline to about 555,000 tons, or 80,000 tons under last year's figure. Big reason is the increasing production and acceptance by industry of man-made rubber.

Now See Here

New techniques in microscopy can be adapted to chemically analyze particles of matter as small as 0.000000000001 gm. Technique is an outgrowth of instrumentation work on intercontinental missiles.

Pipe Down

Steel pipelines have become one of the country's major transportation systems. The buried network of steel pipe now totals about 380,000 miles in length. Approximately 17,000 miles of new pipeline will be added this year.

Redhanded

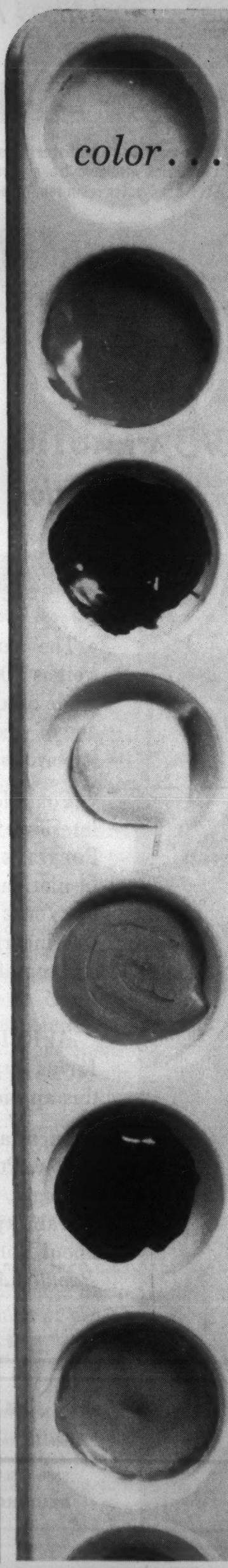
Neoprene industrial gloves are now being colored red. Safety men believe that the colored gloves' greater visibility can be a factor in preventing accidents.

Leaves of Metal

Palladium can be beaten into a leaf less than 0.000005 in. thick. The leaf is used to decorate books and leather where a white nontarnishing finish is desired.

Nylon for Drawers

Nylon cabinet hardware plated by the vacuum metallizing process combines high strength with attractive design. Finish can be chromium, brass or copper.



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Introducing . . .

Henry R. Clauser

M & M's New Editor

■ Upon certain occasions, it becomes the duty of the publisher to speak directly to you, the readers of this magazine. This, I believe, is such an occasion, for it is my pleasure at this time to introduce your new editor, Henry R. Clauser, who officially assumed this post on Feb 1.

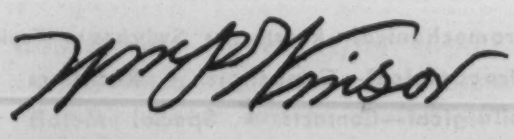
Formerly managing editor, Mr. Clauser has been with MATERIALS & METHODS more than 11 years. An engineering graduate of the University of Michigan, he first came to the staff from American Car & Foundry Co. in 1941. He soon left to join the U.S. Army, where much of his effort was devoted to the development and testing of armor plate. He returned to the staff in 1946 and served as an associate editor until 1950, when he became managing editor.

In recent years, Mr. Clauser's work has manifested itself particularly in what we believe to be the improved appearance and readability of the magazine. Recognizing that the ever growing volume of communication in industry puts a premium on reading time, we have, under his leadership, attempted to develop a format which will help you locate quickly, without wasted time and effort, the information you need in your own work. Our efforts in this direction are continuing.

Mr. Clauser has participated in the work of many technical societies. He is an active member of two committees of the American Society for Testing Materials: Committee E 7 on Nondestructive Testing and Committee B 9 on Metal Powders and Metal Powder Products. He serves on two committees of the Society of the Plastics Industry, including the Engineering and Technical Committee. A member of the American Society for Metals, he has served on several committees of the New York chapter. He has been very active in the American Welding Society, serving as chairman of the New York chapter, as chairman of the national Publicity Committee, and in many other capacities. He has been an active member of the Society for Nondestructive Testing. He is one of four editors who drafted the technical program for the Design Engineering Conference being held this month in conjunction with the Design Engineering Show.

Mr. Clauser has had considerable experience in radiography, both at ACF and as an Ordnance officer at Aberdeen Proving Ground during World War II. Several years ago, his experience culminated in a text, "Practical Radiography for Industry," which is generally regarded as the standard work in the field.

When a new editor takes over a publication, changes are bound to occur. Mr. Clauser and his staff are already planning several innovations that will make MATERIALS & METHODS still more useful to you. However, although our format, even our content, may change to some degree as the years pass, our single goal remains what it has been for many years now: a magazine to help engineers and designers select the most advantageous materials, forms and finishes for both consumer and industrial products.



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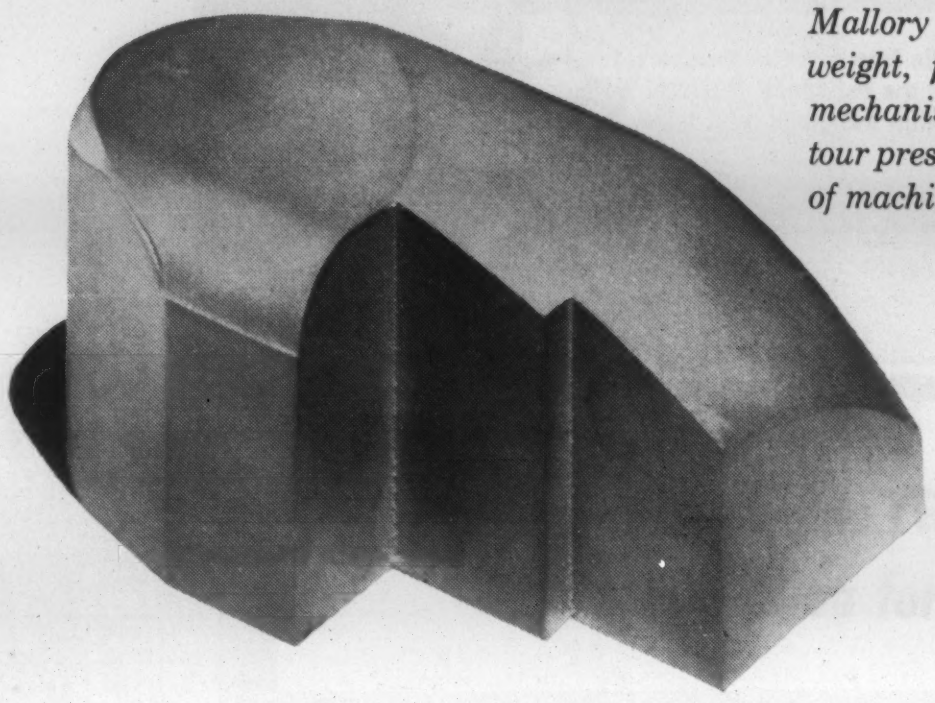

Mallory 1000 Metal counterweight, for an aircraft control mechanism, is produced by contour pressing at one-third the cost of machining from a solid blank.

Mallory Contour Pressing Cuts Costs of High Density Metal Components

COMPLEX SHAPES of high density Mallory 1000 Metal, for use in counterbalances, counterweights and similar mass components can often be manufactured *without any* rough or finish machining.

The exclusive Mallory contour pressing technique* permits forming, in a single, economical operation, a wide range of complex shapes from Mallory 1000 Metal. Dimensions and surface finish are held to close tolerances that are ample for many types of products, with no subsequent machining being required. Even for extremely close tolerance parts, contour pressing sharply reduces the amount and the cost of final grinding or cutting.

The unique combination of strength, density and uniformity offered by Mallory 1000 makes it industry's top choice for weight elements in aircraft controls, gyroscope rotors and similar devices. Strict quality control during manufacturing assures rigid adherence to specifications, in each piece and throughout every lot.

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*Patent applied for

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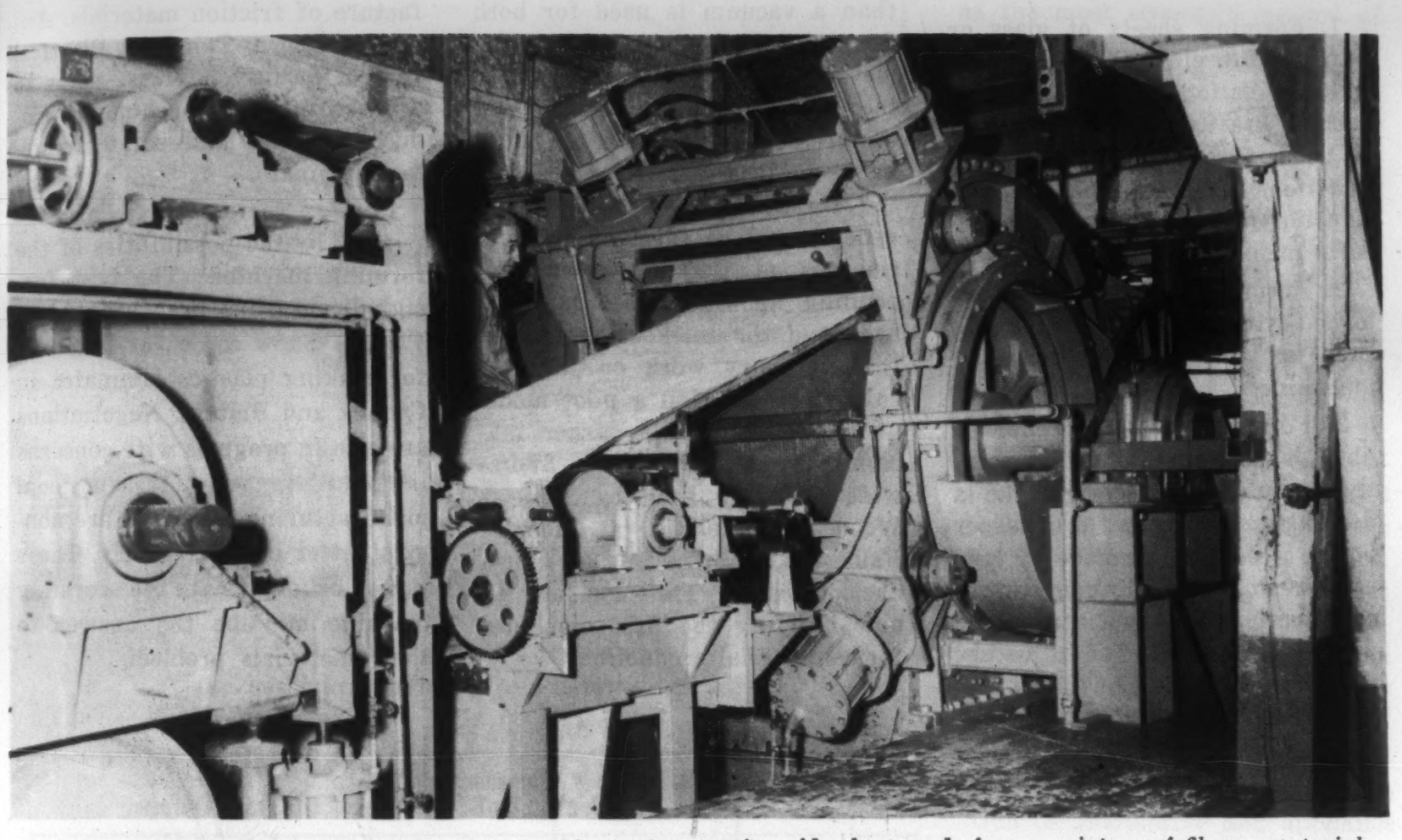
MATERIALS ENGINEERING NEWS

This month

- *Die Castings Survey*
- *ASTM Standards*
- *Telephone Poles*
- *Aluminum Price*



Forming machine *Pilot model of forming machine emits a 37-in.-wide sheet made from a mixture of fibrous materials.*

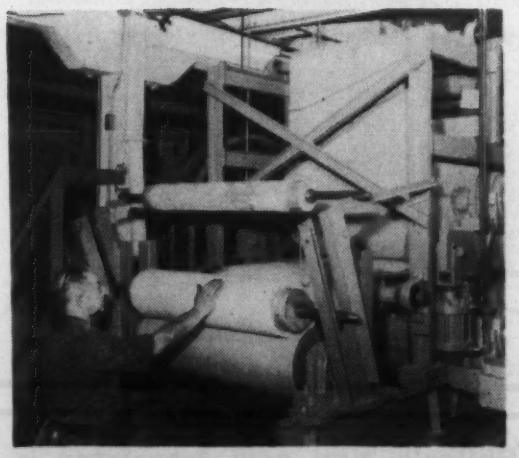
Usable Sheet Products Formed from Waste Materials

■ An invention called a "forming machine" can manufacture a monolithic sheet from any material that will flow with water. The machine's versatility in processing a wide variety of materials is claimed to open up unlimited possibilities for the utilization of waste material.

Engineers of the Forming Machine Co. of America, Inc., in Bound Brook, N. J., have found that a very satisfactory product can be obtained by using various fibers combined with phenolics, vinyls or any resins that are not soluble in water and can be held in suspension with the fibers. The sheets come off the machine at 50 to 80% solids, and after drying they can be pressed or laminated. Sheets can also be coated with colored resins or aluminum powder before final drying.

Potential uses

Experiments have also been conducted using phenolic resins combined with paper mill effluents or sludge. Other fibers such as bagasse, cork, leather findings, balsa wood and kapoc have been used in various combinations. All



Continuous sheet *After drying, sheet formed on machine is collected on rolls. Sheet can be coated with colored resins before final drying.*

of these mixtures were used with vinyl and polyethylene resins, and work with emulsions of polyester resins is now in progress.

Developers of the machine foresee its greatest use in the plastics industry. The machine shows promise for:

1. Forming sheets of glass or other reinforcing fibers alone or in combination with filler fibers such as kraft. These sheets would be used in reinforced plastics applications such as pipe, automotive and marine bodies, and structural members.

2. Forming sheets of fibers loaded with one of several resins such as phenolic, polyester or melamine.

3. Forming sheets of cellulosic fiber loaded with phenolic resin that would be used to make a decorative laminate. A cheaper board could also be made by lowering resin content by using lower cost resins or by introducing waste fibers.

4. Forming sheets loaded with vinyl resin for use as fiber tile.

5. Forming sheets loaded with latex for use in gasketing.

How machine works

The forming machine reverses the usual methods of sheet formation in that compressed air rather than a vacuum is used for both forming and water removal. The material to be formed is pumped into the forming chamber, and compressed air forces the fluid mass against the wire mesh on the forming cylinder. A homogeneous mat or sheet of material emerges at varying speeds depending upon the feed material used and the thickness required.

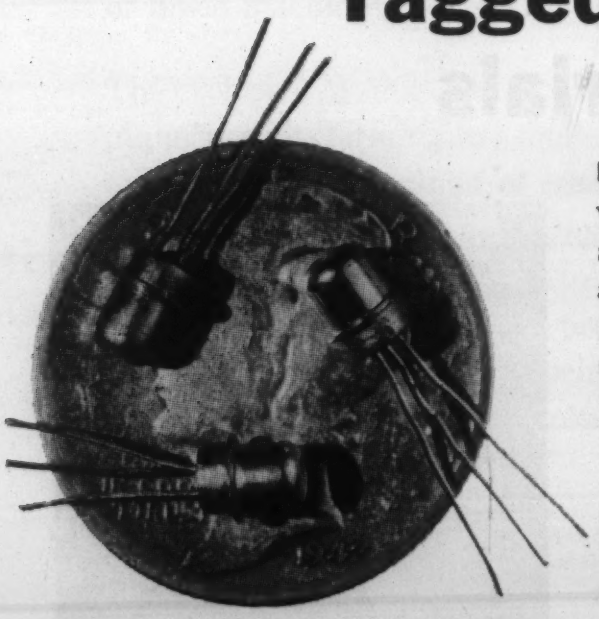
Preliminary work on the machine was done on a pilot model at Bound Brook. A larger machine which produces a 37-in.-wide sheet was built by Noble & Wood Machine Co. at Hoosick Falls, N. Y., for testing on a production basis. This company is now building the first machines for commercial production.

Licenses granted

A number of licenses have been granted to companies interested in adapting the machine to their products. One license has been issued to American Brake Shoe Co. which plans to test the machine's application in the manufacture of friction materials. Another concern, Trimount Plastics, Inc., of Arlington, Mass., plans to use the forming machine to produce a stain- and scratch-resistant laminate.

Foreign companies are also intrigued by the possibilities of the forming machine. The first foreign license has been granted to Francis Shaw & Co., of England, for making plastics laminates in Canada and Britain. Negotiations are also in progress with concerns in countries where conventional manufacturing materials are nonexistent or in short supply. These firms believe that the forming machine may be the answer to their materials problem.

Sub-Miniature Transistor Tagged for Rugged Service

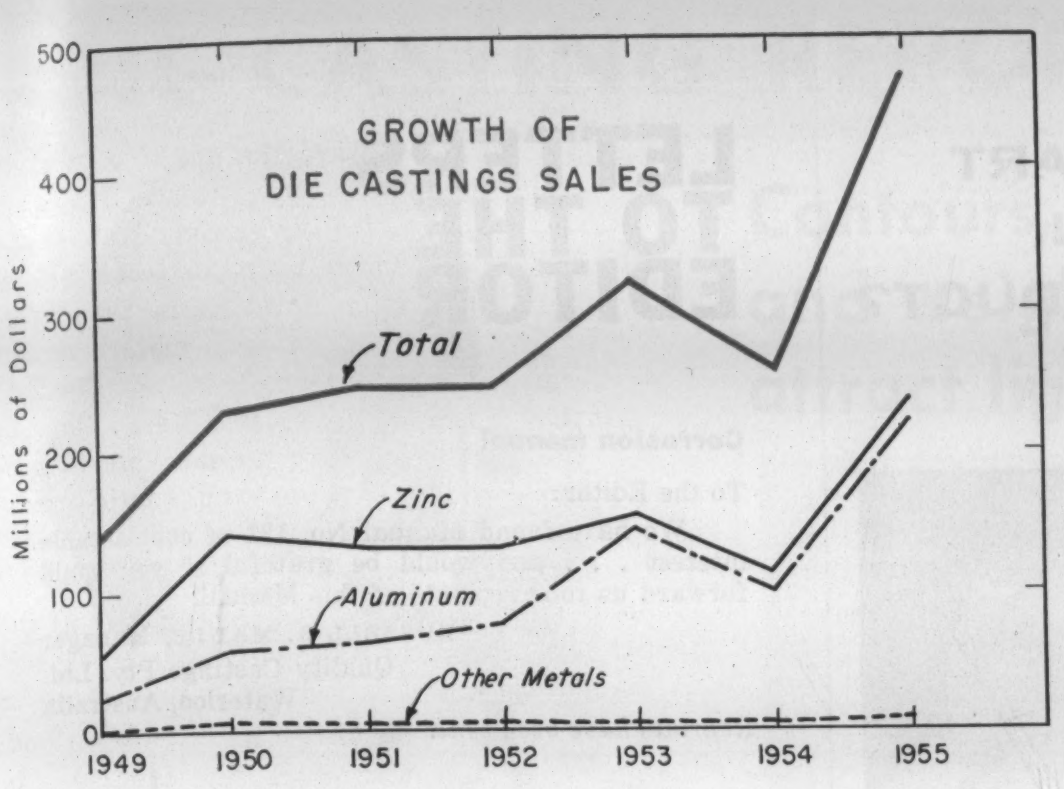


Philco's tiny new transistor is *believed to be the smallest yet developed. It can be used in guided missiles and computers where miniaturization is vital.*

■ Slated for electronic systems where miniaturization and rugged service life are important factors, a "sub-miniature" transistor is going into production at Philco Corp. The new transistor, named the M-1, is so small that more than 20 can be placed on a dime.

As in most junction transistors, the basic operating portion of the M-1 consists of a wafer of germanium. In this case, however, the wafer is about the size of a pinhead and leads are soldered to a dot of indium on each face of the wafer. In spite of its tiny size, the transistor is covered by a metal can which is hermetically sealed by welding to protect the device from moisture.

Philco engineers state that the M-1 transistor possesses unusual strength by virtue of its size. Excess mass — a weakening factor — has been eliminated. The device can withstand an acceleration rate of 20,000 "G's" (20,000 times the force of gravity) without change in characteristics. It also has the transistor's inherent qualities of long life, ruggedness, light weight and low power consumption. The M-1 will operate on as little as 0.0001 watt.



Die Casting Sales Hit New Peaks in 1955

END USE DISTRIBUTION OF DIE CASTINGS IN 1955

Industry Groups	Zinc		Aluminum		Magnesium	
	% of Total	Estimated Tons	% of Total	Estimated Tons	% of Total	Estimated Tons
Agricultural Equipment; Mining and Construction Machinery	1	3000	2	3125	<1	3
Automotive (except military)	59	163,500	43	58,500	37	975
Other Transportation (except military)	1	2500	2	2000	<1	15
Industrial Machines and Tools; Commercial Equipment	7	18,500	15	20,000	34	900
Electronics	2	4500	1	1125	<1	6
Office and Business Machines and Equipment	2	5750	5	6250	6	160
Builders Hardware; Plumbing and Heating	5	13,000	3	3650	<1	12
Photographic Equipment; Optical, Recording, Scientific and Measuring Devices	2	5500	5	7250	2	42
Timing Devices and Clocks	1	2750	1	1500	<1	3
Home Appliances	18	51,000	18	25,250	8	197
Toys; Jewelry; Personal and Sporting Goods	1	3250	2	2850	<1	12
National Defense	1	1750	3	3500	11	275
Total [a]	100	275,000	100	135,000	100	2600

[a] *Totals represent all job shop sales. Captive use not included.*

■ Sales of die castings produced by job shops in 1955 reached $458 million, an increase of 40% over the previous high year of 1953. According to David Laine, Secretary of the American Die Casting Institute, this growth is evidence of the acceptance of die castings as the most economic method of producing custom engineered nonferrous metal parts.

Breaking down last year's sales figure, zinc die casting sales accounted for $232 million; aluminum, $214 million; magnesium, $6.5 million; and brass, $5 million. No sales figure is available for die castings produced in captive shops owned by end-product manufacturers.

Industry trends

Excluding shipments for national defense, zinc die casting's use shows gains in eight of the eleven customer industry groups. Aluminum has an even better record with a drop in use indicated in only one of the eleven groups; and this surprisingly enough was in the electronics industry.

Zinc die casting's use, in addition to automotive and appliance gains of 92,500 tons, showed a net gain of some 450,000 tons in other uses. Aluminum die castings gained 355,000 tons in automotive and appliance uses and over 100,000 tons in other uses.

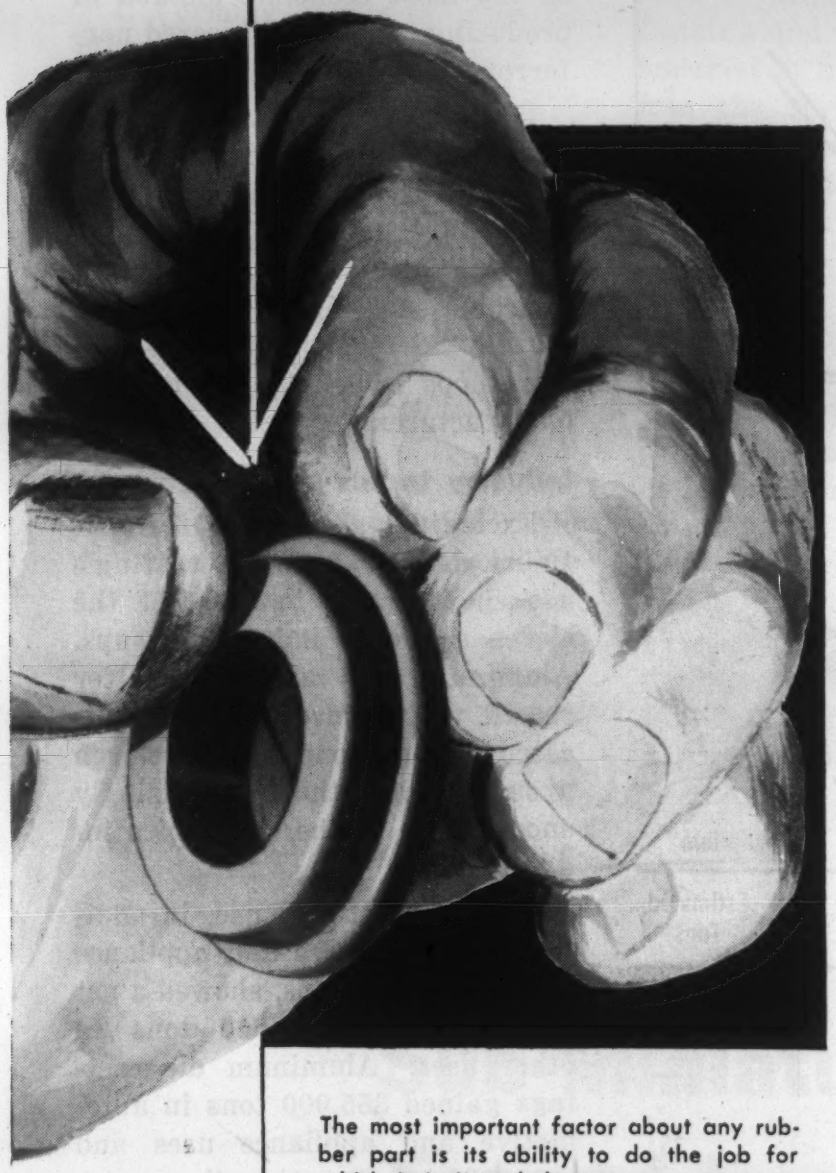
Job shop die casting shipments represented about 67% of the zinc and 77% of the aluminum sold for die casting purposes. The balance represents captive output. With few exceptions, the larger captive producers are also very substantial purchasers of die castings. The trend here is for increasing both production and purchases, so a relatively stable ratio will very likely be maintained.

Metal consumption

Total die casting use of aluminum reached 292,500 tons, over 9% of the total aluminum supply. Of this quantity, 176,000 tons represent production of aluminum die castings, and 165,000 tons the

(Continued on p 278)

DOES
THIS
RUBBER PART
BELONG IN
YOUR PRODUCT?



The most important factor about any rubber part is its ability to do the job for which it is intended. Most parts are specifically engineered for the application . . . and consideration is given to elasticity, temperatures to be encountered as well as resistance to petroleum derivatives, chemicals and abrasion.

STALWART ENGINEERS have the experience and facilities to compound special rubber stocks to meet even the most unusual requirements . . . and from more than 500 different compounds already at their disposal, they can mold, extrude, die-cut, lathe-cut or mandrel-build shapes to meet any specifications.

SPECIFY STALWART RUBBER PARTS FOR THAT ONE ESSENTIAL QUALITY . . . THE ABILITY TO DO A JOB . . . BEST!

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RUBBER COMPANY
165 Northfield Road • Bedford, Ohio

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For more information, turn to Reader Service Card, Circle No. 418

LETTERS TO THE EDITOR

Corrosion manual

To the Editor:

We have found Manual No. 121 of considerable interest . . . and would be grateful if you could forward us four reprints of this Manual.

RUSSELL R. MAULE, Manager
Quality Castings Pty. Ltd.
Waterloo, Australia

Reprints have been sent.

M&M manuals

To the Editor:

We would like to take this opportunity to inform you that your manuals have been of great assistance to us in our engineering work. As manufacturers of extrusion and forging presses, and rolling mills for the steel and aluminum industries, we were particularly impressed with your treatments of extruded shapes and wrought aluminum alloys in Manuals 61 and 123. You can be assured we are awaiting with interest the continuation of your Manual series.

STANLEY SPIEGELMAN
Loewy-Hydropress Div.
Baldwin-Lima-Hamilton Corp.
New York, N. Y.

Uncommon composition

To the Editor:

Could you send me information on suppliers of asbestos filled vinyl which can be compression molded at a temperature of 300 F or less. We would want to use this material in sheet form approximately 14 x 24 in. and 0.08 in. thick.

CALVIN C. SEAQUIST
J. W. Clement Co.
Buffalo, N. Y.

We do not know of any suppliers of asbestos filled vinyl. Can any of our readers help out?

It's only 90%

To the Editor:

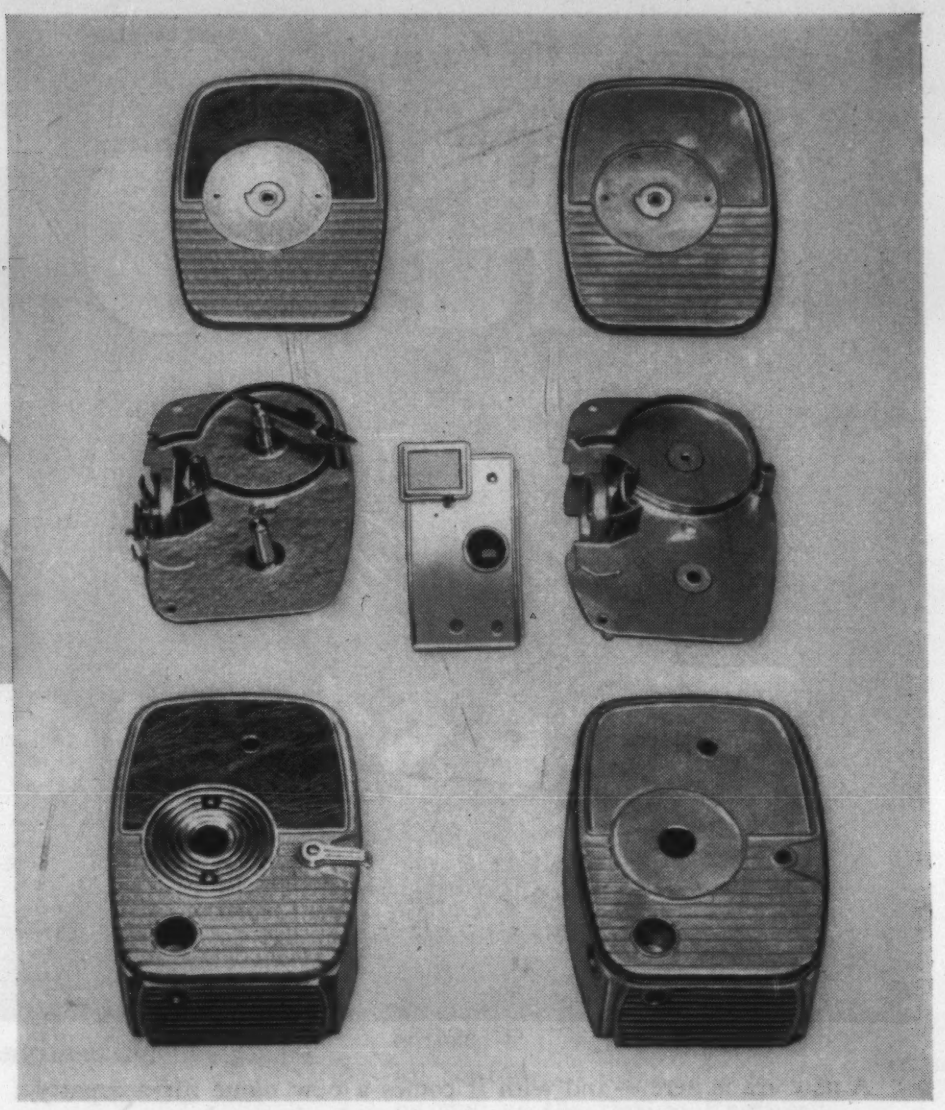
I am puzzled by the omission of No. 16 (spinnings) from the last column (opposite tin alloys) on page 136 of the Fabricated Metal Parts manual. It says on page 130 that pewter is one of the metals "most commonly converted into spun shapes," and if pewter is *not* a tin alloy, I wonder what *is?*

LYNN W. MEEKINS, Director
The Malayan Tin Bureau
Washington, D. C.

Touché! Spinnings most certainly should have been listed as one of the forms in which tin alloys, particularly pewter, are commonly available.

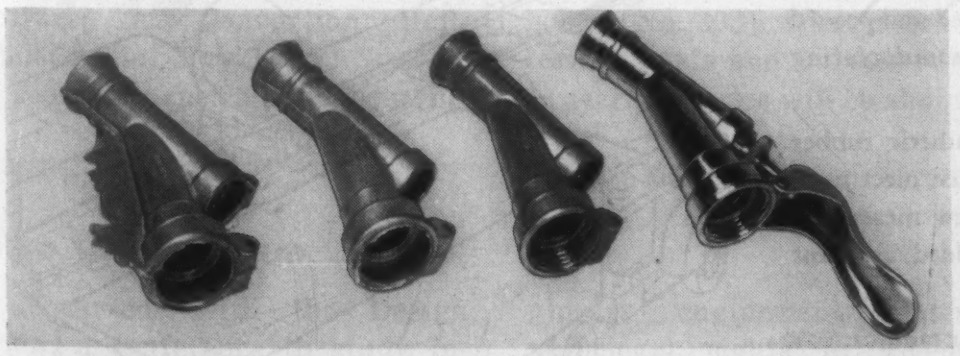
DIE CASTING REPORT

Contours, clever design and weight saving... attract light industry



The photographic industry, long a user of aluminum die-castings, is daily finding more ingenious ways of using this cost-and-weight saving process. Look at this Keystone 8 mm Capri movie camera. (1) A cast groove in the cover provides a positive light seal—almost impossible to achieve economically by other processes; (2) the mechanism plate features a cast film guide, a governor housing and cored holes which all simplify and speed assembly; (3) much machining is eliminated by cored holes and part has buffed finish for customer chrome plating, and (4) exceptionally smooth finish on case plus streamlined appearance and detail were possible only with die-castings.

Clever engineering and major use of die-castings enable Keystone to produce a quality, precision camera at a price designed to attract volume sales.

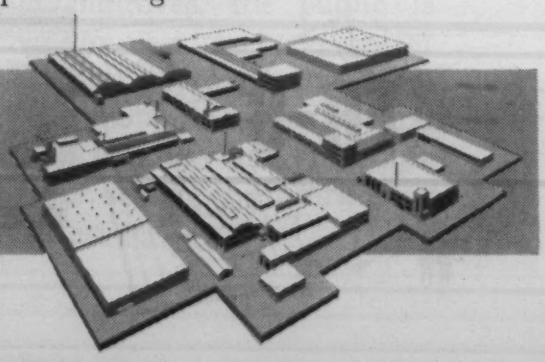


Lawn Spray Nozzle Three core pulls, a 2 impression die, and a production of close to 300,000 zinc units per season. That's the story of this complicated little die-casting. Machining included punch press parting line, facing nozzle end and seat, reaming core flash at junction of two cores, facing hose connection, drilling one pin or shaft hole, and tapping hose thread and plunger cylinder end. All operations done by Precision. An example of perfect integration.

Write on your letterhead for a copy of "Die-Castings...Unlimited." Address: Precision Castings Co., Walnut St., Fayetteville, N. Y.

PRECISION CASTINGS CO.

A DIVISION OF **HARSCO Corporation**



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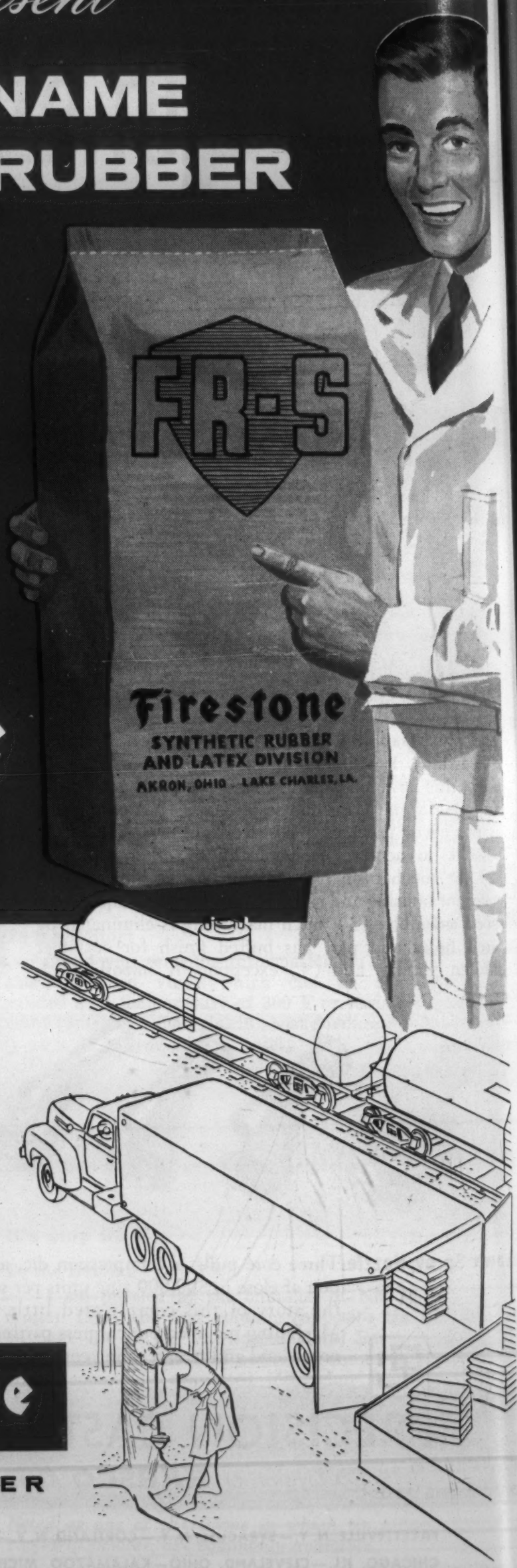
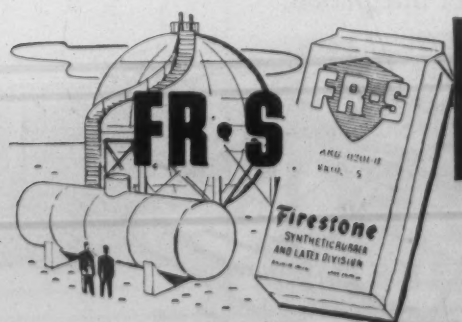
The World's Largest Rubber Producer



A new era is here—and with it comes a new name for a greatly improved rubber! More than just a new name, FR-S is Firestone's new HIGH STANDARD of synthetic rubber . . . already tested and proved . . . and now in large scale use in Firestone's own manufacturing operations.

During the past year, every phase of Firestone's synthetic rubber manufacturing has been modernized. Raw materials must meet new, HIGHER STANDARDS. New, improved techniques; new measuring devices, and scientific methods of control have been added as plant capacity has been expanded.

FR-S is available in latex or dry rubber . . . in drums or tank car . . . bales or carload quantities. A Firestone Technical man will be glad to give you further information on FR-S and its applications. Phone or write Firestone, Synthetic Rubber and Latex Division, Akron, Ohio.



Firestone

BEST IN RUBBER

For more information, turn to Reader Service Card, Circle No. 596

May 14-17, 1956

Convention Hall, Philadelphia

The First Annual Design Engineering Show

. . . . and Design Engineering Conference

The Show

A comprehensive array of the latest developments in metals, nonmetallic materials, finishes and fasteners will be featured at the new Design Engineering Show. Intended for all engineers and designers responsible for product, component and machinery design in all manufacturing industries, the show will make its initial appearance at Convention Hall, Philadelphia, May 14-17.

Technical specialists from almost 200 companies will be on hand to give expert advice to visiting engineers. About half the exhibits will display new and existing engineering materials; the remainder will display mechanical and electrical components used in engineering design.

Visitors will be especially welcome at the MATERIAL & METHODS booth (No. 303) where actual materials, parts and finishes covered in recent articles will be shown.

How to Register

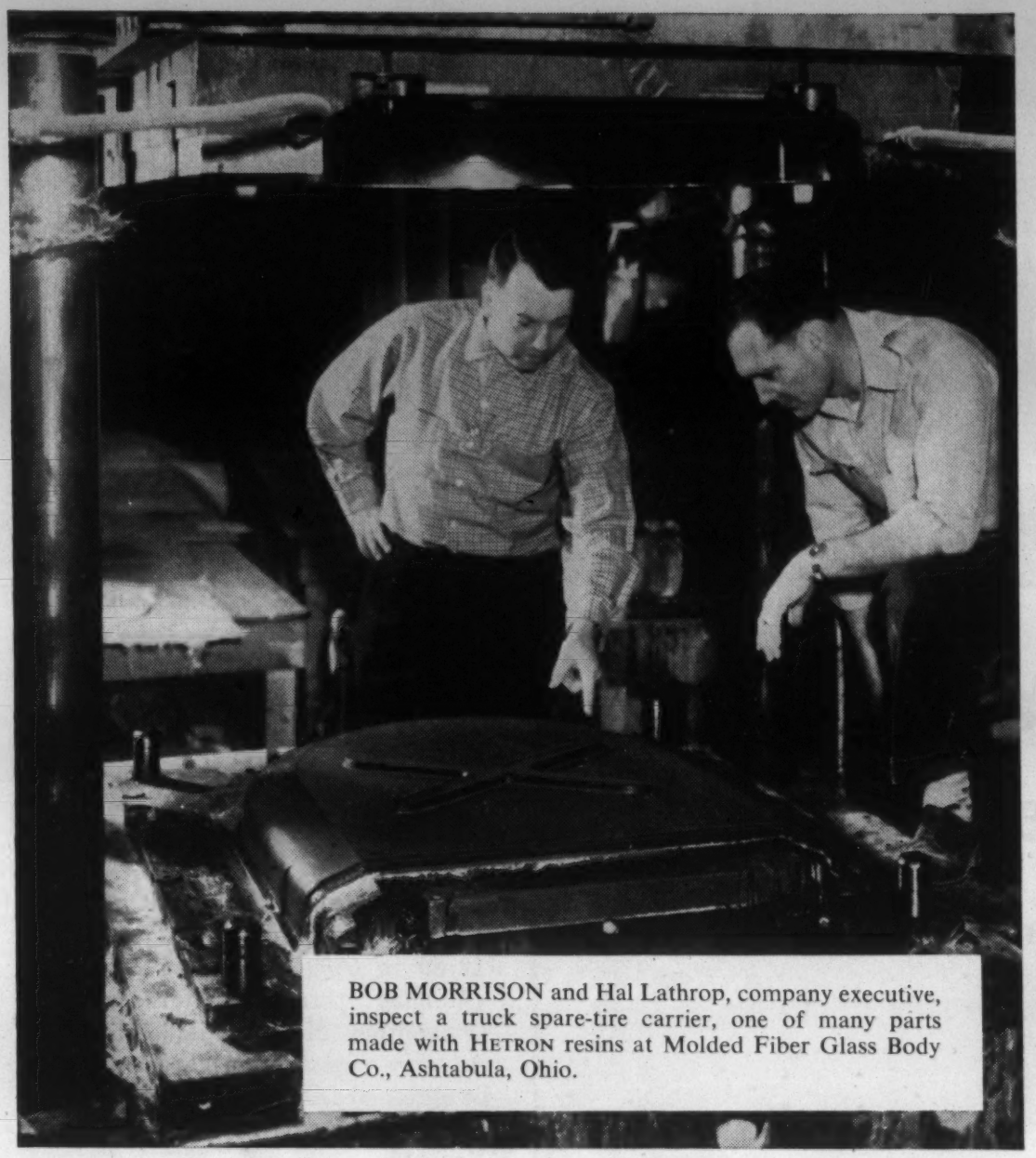
Registration for the show is free and can be made at any time during exhibiting hours—12:30 to 5:30 p.m., May 14-17 (Monday through Thursday), Convention Hall, Philadelphia. Advance registration cards may be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17.

Registration for the conference can be made at the ASME desk in the main lobby of Convention Hall from 9:30 a.m. to 12:30 p.m., May 14-17. The conference fee, $5 for ASME members and $10 for non-members, entitles the registrant to attend all conference technical sessions as well as the Design Engineering Show itself. In addition, each registrant will receive copies of all papers delivered at the conference.

The Conference

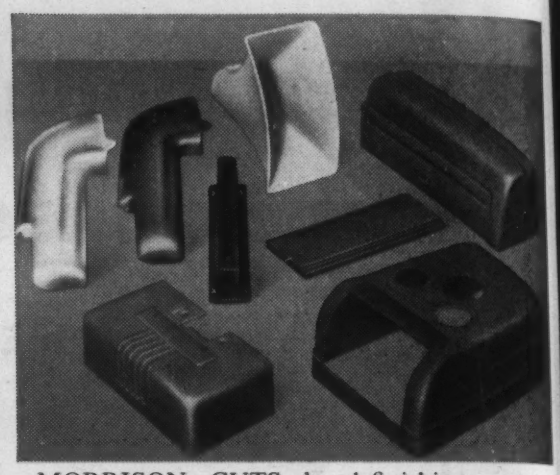
Concurrent with the Design Show, a conference to study industry's problems in design engineering will be held at the ballroom of Convention Hall under the sponsorship of the Machine Design Division of the American Society of Mechanical Engineers. Conference sessions will be devoted to such varied topics as: cost reduction in product design, procurement and training of engineers, engineering materials, and legal rights to inventions (see complete program on p 21).

The need for a conference of this type has been clearly stated by Robert M. Conklin, chief of the mechanical engineering division of Battelle Memorial Institute and chairman of the ASME Machine Design Division. "There is an urgent need for a national conference to consider current problems in design engineering. Each new development in automatic, high-speed production equipment presents scores of design problems. As design engineering improves, the public is benefited by new products, better products and less expensive products. We hope to stimulate industrial thinking and planning for better design engineering by this conference."



BOB MORRISON and Hal Lathrop, company executive, inspect a truck spare-tire carrier, one of many parts made with HETRON resins at Molded Fiber Glass Body Co., Ashtabula, Ohio.

ALL MOLDED FIBER GLASS PARTS for this pickup are molded by the Body Co., and all use HETRON resin. These parts combine high reverse impact with excellent flexural strength. The ultra-smooth "showroom" surface will take a baked-on alkyd finish without cracking or crazing.



MORRISON CUTS hand-finishing costs as much as 50% by using HETRON on parts like these. HETRON gives a glossy, well-filled surface—beautiful as is, or with a baked-on finish.

"I get the quality moldings I want—with HETRON"

says **Bob Morrison,** *President, Molded Fiber Glass Body Co.*

It's no easy job to meet the requirements of the automotive industry for reinforced polyester body parts.

But Bob Morrison is doing it. Here, in his own words, he tells why he molds with HETRON:

"To make good matched-metal-die moldings of auto body and other large parts, we find it advantageous to use a polyester with the resiliency of a semi-rigid resin, plus the flexural strength of a rigid resin.

"The resin must come through a short cure with practically no surface shrinkage. It must give us an extra-smooth, glossy surface, using the normal resin-to-glass ratio—and with a bare minimum of hand finishing and rejects.

"Then the finished part must take a baked-on alkyd finish at the customer's assembly plant, without a trace of surface crazing.

"It's worth paying a few cents more per pound for resin that gives us results like these in the finished product.

"We get this kind of quality with HETRON resins. Our cost is lower in the long run, because HETRON substantially reduces the amount of hand finishing we have to do."

Bob Morrison gets quality moldings —and so can you—with HETRON.

HETRON resins come to you with permanent, built-in flame resistance. This added bonus can be utilized to its highest degree with the proper choice of fillers.

If you need an assembly, a single part, or a molding material with properties like these, you'll save time by specifying a HETRON resin. HETRON costs a little more. But it gives you results worth a *lot* more.

You'll find technical information on HETRON® resins in your Sweet's Product Design File. Or write us today for complete technical data, and names of fabricators who can supply you with HETRON-based material.

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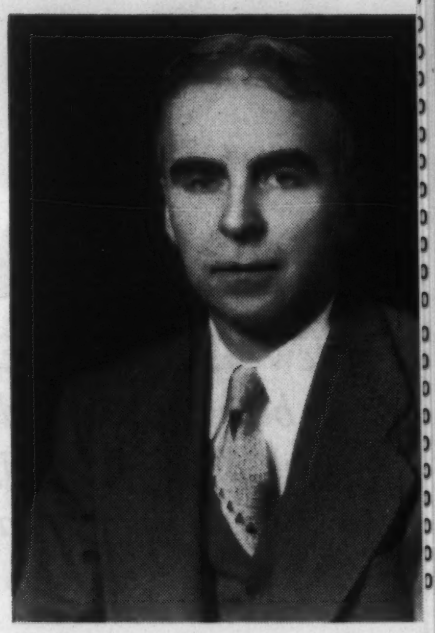

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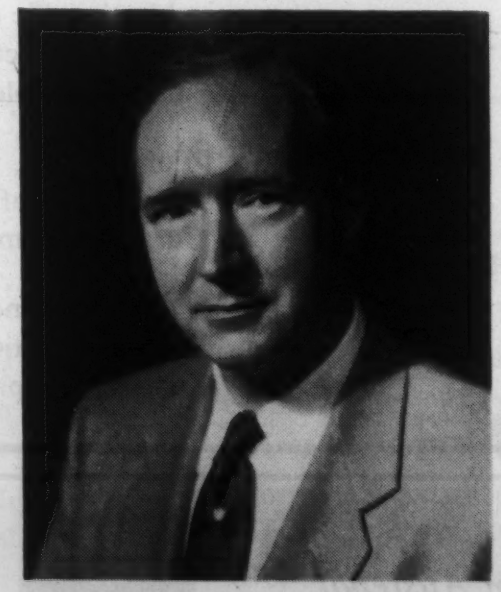
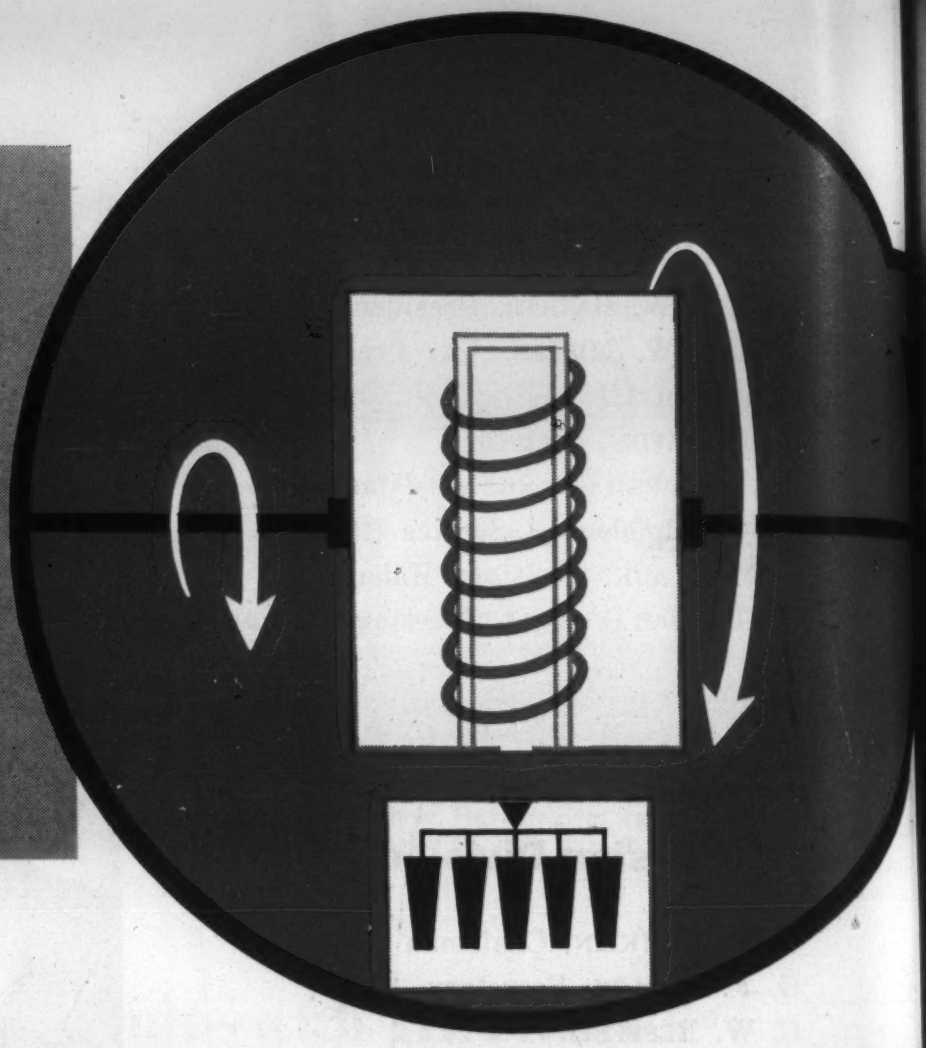


COLIN CARMICHAEL, Editor, *Machine Design*

design with austenal in mi



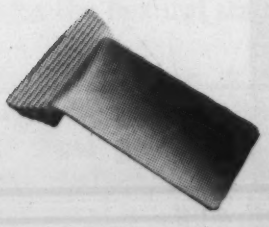
New **VACUUM MELTING** *techniques being developed by* **MICROCAST** *give promise of higher performance parts for the future*

Austenal vacuum melting and casting techniques being currently develope may have a big place in your future designs.

Vacuum melting promises greatly improved investment castings and a wide range of cast parts, because it makes available alloys with outstanding high temperature properties. By removing harmful gases and holding down objectionable oxide inclusions, vacuum melting results in parts that are more ductile, stronger and tougher than before. Vacuum melting makes possible the use of alloys that were formerly uncastable.

For instance, these new Austenal techniques are already being studied for aircraft manufacturers on a development basis. Vacuum melting has helped furnish extremely high quality vanes and blades for future jet engines.

Discuss this new Austenal development with your Austenal representative. Vacuum melting may be the way for you to obtain higher performance in designing parts for tough jobs of the future.



---It's **NEW** *from Austenal*

Vacuum casting of turbine buckets such as this has been accomplished and the application of this method is being planned for other jet engine components.

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Design Engineering Conference
Ballroom, Convention Hall

Program of Technical Sessions

Monday, May 14, 9:30 a.m.

Session I Value Analysis in Product Design

Chairman: VICTOR F. SEPAVICH, Director of Engineering, Crompton and Knowles Loom Works

Vice-Chairman: H. R. CLAUSER, Editor, *Materials & Methods*

Speakers: A. D. BENTLEY, Specialist, Value Analysis Services Section, General Electric Co.

W. L. HEALY, Supervisor, Data Bureau, Philadelphia Works, General Electric Co.

Tuesday, May 15, 9:30 a.m.

Session II How to Get and Train Engineers (panel session)

Chairman: PHILIP R. MARVIN, Consultant, American Viscose Corp.

Vice-Chairman: COLIN CARMICHAEL, Editor, *Machine Design*

Panel Members: CHESTER LINSKY, Dept. of Industrial Engineering, Pennsylvania State University

A. A. JOHNSON, Manager of Engineering, Switchgear Div., Westinghouse Electric Corp.

DR. BERNARD J. COVNER, Asst. Vice-President, Dunlap and Associates

Wednesday, May 16, 9:30 a.m.

Session III Materials Selection

Chairman: CLIFFORD EDDISON, Manager, Chemical and Physical Laboratory, Radio Corp. of America

Vice-Chairman: FRANK OLIVER, Editor, *Electrical Manufacturing*

Speakers: "Selecting Engineering Materials for Products," W. A. IRVINE, Manager of Production Engineering, The Maytag Co.

"Problems in Miniaturization," WILLIAM C. SCHMIDT, Systems Development Engineer, Merrimack Valley Laboratory, Bell Telephone Laboratories

Thursday, May 17, 9:30 a.m.

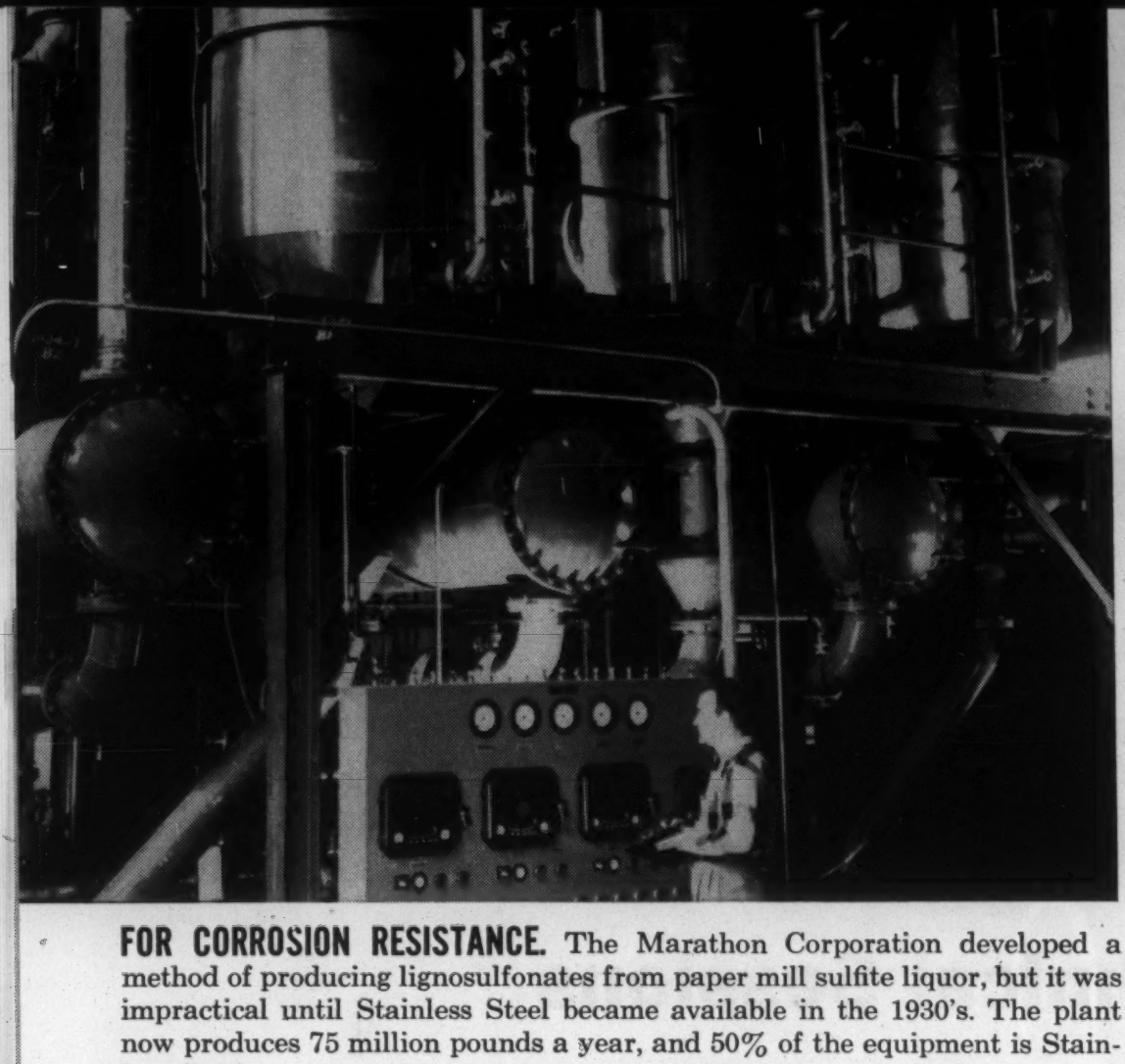
Session IV Employee Patents and Inventions

Chairman: DONALD FINK, Director of Research, Philco Corp.

Vice-Chairman: FRANK PIASECKI, Piasecki Aircraft Corp.

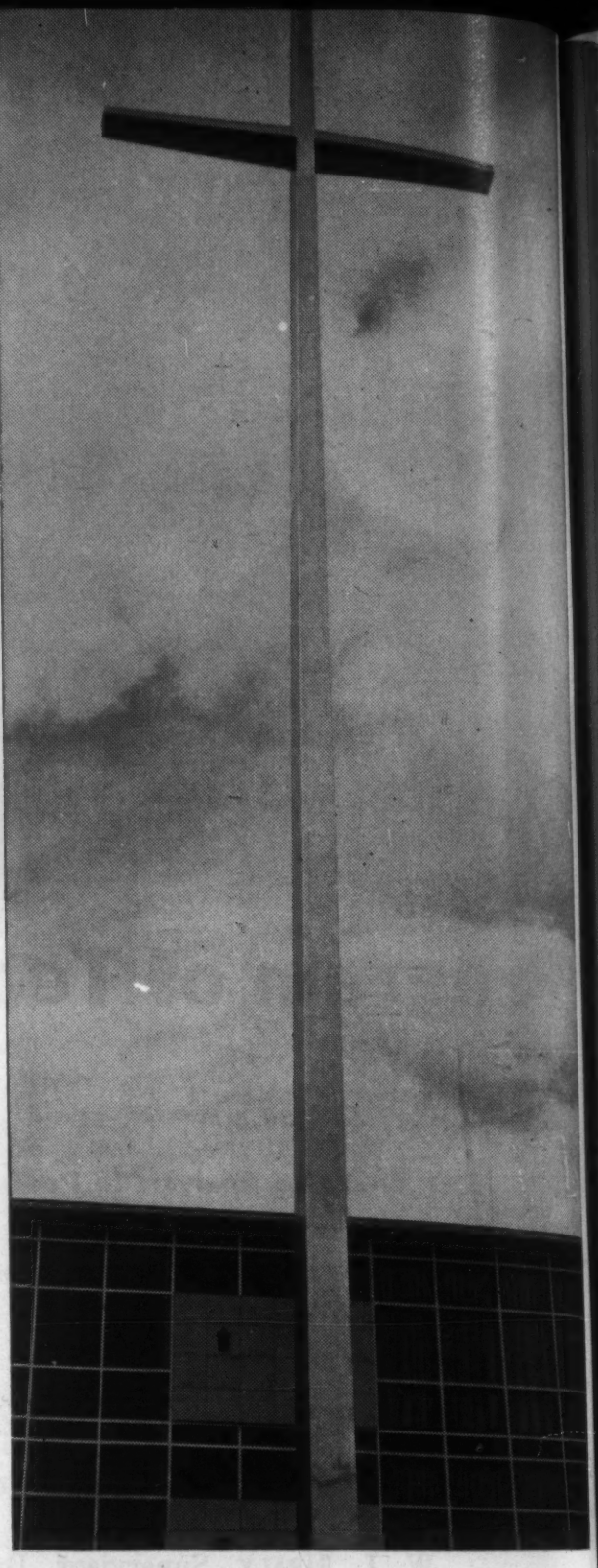
Speakers: "Recognition and Reward for Invention," W. A. STEIGER, Manager, Patent Dept., Westinghouse Electric Corp.

"Rights of the Employee's Inventions," GEORGE V. WOODLING, Patent Attorney



FOR CORROSION RESISTANCE. The Marathon Corporation developed a method of producing lignosulfonates from paper mill sulfite liquor, but it was impractical until Stainless Steel became available in the 1930's. The plant now produces 75 million pounds a year, and 50% of the equipment is Stainless Steel.

NOTHING *can equal* *Stainless Steel*



FOR ENDURING BEAUTY. This great religious symbol is erected on the grounds of St. Patrick's Academy, Chicago, Ill. The Stainless Steel skin furnishes a gleaming, permanent inspiration to all viewers.

• No other design material can match Stainless Steel in its *combination* of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When buying Stainless, remember that United States Steel offers the widest range of types, finishes and sizes available in the United States.

FOR WET, ABRASIVE SERVICE. Here's a Stainless Steel shaker screen in a coal plant. Management says, "Ordinary screens would only last about two weeks, but we can expect three *years* of service from these Stainless Steel screens . . ."

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MANUFACTURERS' LITERATURE

New Literature

TRADE SHOWS

PLASTICS SHOW & CONFERENCE. Society of the Plastics Industry, Inc. Literature describing National Plastics Exposition and concurrent Plastics Industry Conference—to be held in New York City, June 11 to 15. (1)

Stainless Steel. Allegheny Ludum Steel Corp. Data sheet on Type 301 used for automobile trim, show cases, stove fronts and cooking utensils. (2)

Carbonyl Iron Powder. Antara Chemicals Sales Div., General Aniline & Film Corp., 9 pp. Densities, permeabilities and other data on an almost pure iron powder (3)

Nickel Plated Steel. Bart Mfg. Corp., 6 pp, illus. Developed during World War II for atomic purposes, Bart Lectro-Clad pipe now controls corrosion in water systems, in natural gas production, and in the pulp and paper, organic chemical and inorganic chemical fields. (4)

Molybdenum. Climax Molybdenum Co., 4 pp, No. Ch-3. Describes 42 molybdenum chemical bulletins that may be ordered. (5)

Chemical Rubber. E. I. du Pont de Nemours & Co., Inc., Elastomers Div., 8 pp, illus. Why the heat, weather, ozone and chemical resistance properties of Hypalon, a synthetic rubber, are valuable in product design and plant maintenance. (6)

Steel. Firth Sterling, Inc., 2 pp, Nos. 20-011, 10-082. Data sheets on resulfurized high carbon, high chromium steel and resulfurized tungsten-molybdenum high speed steel. (7)

Powder Metallurgy. Harper Electric Furnace Corp. Bibliography of periodical references to powder metallurgy. Covers nearly 250 articles printed in 1954 and 1955 in the U.S., England and Canada. (8)

Polyvinyl Chloride. H. N. Hartwell & Son, Inc. 6 pp, No. 4B. Facts about Boltaron PVC used for sheets, bar stock, pipe fittings, pipe, blocks, welding rod and valves. (9)

Powdered Iron and Bronze. Johnson Bronze Co., 4 pp, illus. Data on Ledaloyl powdered iron and bronze, for self-lubricating bearings, bushings and structural parts. (10)

Carbon and Alloy Steels. Lukens Steel Co., 12 pp. Compares carbon and alloy steels for pressure vessels. Nine graphs included: one plots allowable stress against temperature; the rest show maximum service temperatures from 650 to 950 F. (11)

Aluminum Bronze. Mueller Brass Co., 7 pp, illus. Chemical and mechanical properties of Tuf-Stuf, high copper base alloys. Typical applications include drill jigs, cams, threaded nuts and bolts, lathes, grinders. (12)

Nylon Molding Powder. National Polymer Products, Inc., 2 pp, illus. Properties of Nylatron GS, a molybdenum disulfide-filled formulation. (13)

Metal Designs. Rigidized Metals Corp., 2 pp. Folder contains four metal samples. Company has more than 40 standard patterns, a few of which are shown in photographs. (14)

Tool Steel. Vulcan Crucible Steel Div., H. K. Porter Co., Inc. Tool steel brand chart showing more than 300 varieties of tool steel offered by 12 producers. (15)

Weldment Fabrication. Acme Welding Div., United Tool & Die Co., 6 pp, illus. Describes facilities for planned weldment fabrication. (16)

Stainless Steel Rings. Advanced Products Co., 4 pp, illus. Properties of Metal "O"-Rings for static sealing. (17)

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Brazing. All-State Welding Alloys Co., Inc., 51 pp, illus. Data for brazing shapes, sheet, castings, tubing and assemblies of copper, brass, steel, aluminum and cast iron. Also a buyers' guide. (18)

Plastics vs Reagents. American Agile Corp. Compatibility or noncompatibility of reagents with such thermoplastic materials as polyethylene, nonplasticized polyvinyl chloride, high impact polyvinyl chloride and high tensile, high temperature polyethylene. (19)

Austenitic Manganese Steel. American Brake Shoe Co., 50 pp, illus. Comprehensive booklet on manganese steel. Data on alloys, effects of alloying elements, response to heat treatment, mechanical properties and applications. Bibliography. (20)

Silver Brazing. American Platinum Works, 16 pp. Manual on selective fluxing for low temperature silver brazing. (21)

Electrode Selector. Ampco Metal, Inc., Milwaukee 46, Wis., Price $1.00. Slide-chart for selecting proper electrodes. Other information includes conversion data and spot welding schedules. Write direct to Ampco.

Solder Alloys. Anchor Metal Co., Inc. Selection chart listing the company's line of solder alloys with their melting temperatures (22)

Bonding and Coating. Angier Products, Inc., 13 pp, illus. Manufacturing facilities, laboratory control and custom service for solving problems in bonding and coating. (23)

Coated Abrasives. Armour & Co., Coated Abrasives Div., 6 pp, illus. "How to Store Coated Abrasives" shows that a constant relative humidity prevents deterioration. (24)

Investment Castings. Arwood Precision Casting Corp., 56 Washington St., Brooklyn 1, N.Y. Nine different applications of the investment casting process. Also an outline of the company's facilities for research and development, production, tooling, heat treating and quality control. Write direct to Arwood on company letterhead.

Corrosion Proof Cements. Atlas Mineral Products Co., 12 pp, No. 5-2. Latest data on five standard corrosion proof cements: furan, phenolic, sulfur, polyester and silica based materials. (25)

Nonmetallic Linings. Automotive Rubber Co. Eleven actual specimens of rubber and plastic compounds used in most corrosion and abrasion resistant lining work done by this company on tanks, vessels, pipe, fittings, duct work, fans and other equipment. (26)

Mechanical Tubing. Babcock & Wilcox Co., Tubular Products Div., 4 pp, illus., No. TB-362. Case histories show how electric-resistance-welded, carbon steel mechanical tubing solved engineering problems and simplified production. (27)

Rhodium Plating. J. Bishop & Co. Platinum Works, 5 pp. Data on the preparation of rhodium plating solutions and a stock list of noble metal salts and solutions. (29)

Plastics. Cadillac Plastic & Chemical Co., 52 pp. Catalog of thermoplastic and phenolic sheets, rods, tubes, films, resins, cements and supplies. Compares properties of acrylic, vinyl acetate, polyethylene, polystyrene, nylon, Teflon and Kel-F plastics in cast and extruded shapes. (30)

Carbide Tool Selection. Carboloy Dept., General Electric Co., 66 pp., illus., No. GT-310. Covers effective cutting speeds for carbide tools, machine tool horsepower requirements, how to determine shank size of single-point tools, carbide tool geometrics and carbide grade selection. (31)

Vinyl-Metal Laminates. Columbus Coated Fabrics Corp., 14 pp, illus. Information on a semi-rigid vinyl sheeting that eliminates the need for finishing. Col-O-Vin can be bonded to steel or nonferrous metals. (32)

Felt. Continental Felt Co., Inc., 10 pp, illus. A history of felt, some of its countless uses in machinery, and a description of the company's facilities. (33)

Chromate Sealer. Conversion Chemical Corp., No. P-40. How to use Kenvert No. 40, a chromate sealer for protecting aluminum against corrosion. (34)

Precision Casting. Corning Glass Works, 19 pp, illus., No. GC-2. How Glascast powder is made into a shock resistant precision casting mold for high melting alloys. (35)

Rust Preventing Paper. Cromwell Paper Co., 7 pp, No. 655. Advantages of Ferro-Pak, an inhibitor paper for rust prevention. (36)

Plastic Parts. Harry Davies Molding Co., 32 pp, illus. Control handles, meter cases, knobs and other molded phenolic plastic parts that are available without tooling costs. Also data on standard mountings, inserts, projecting studs and hot stamp engraving. (37)

Vacuum Tube Ceramics. Diamonite Products Div., U. S. Ceramic Tile Co., 9 pp, illus. Comparative properties and typical shapes and sizes of alumina ceramic structures made for vacuum tube assemblies. (38)

Nondestructive Sorting. J. W. Dice Co., 1 p, illus., No. 2007. Describes Model CE Cyclograph for nondestructive sorting of mixed metals by metallurgical characteristics. (39)

Plastics for Lighting. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., 11 pp, illus. Properties of Lucite acrylic resin and applications involving indoor and outdoor lighting. (40)

Polyethylene Waxes. Eastman Chemical Products, Inc., 22 pp, illus. Possible uses for Epolene, a polyethylene wax, include paper coatings, paste emulsions, rubber compounding, coil and condenser coatings. (41)

Optical Aids. Edmund Scientific Corp., 64 pp. Catalog of more than 1000 optical instruments, including magnifiers, microscopes, pocket comparators, hand spectroscopes and photographic items. (42)

Alloy and Stainless Steels. Electric Steel Foundry Co., 102 pp, illus., No. 175-A. Catalog of ESCO alloy and stainless steels. Facilities for static, shell and centrifugal casting also described. (43)

High Alloy Assemblies. General Alloys Co., 4 pp, illus., No. 561. Describes production facilities for high alloy assemblies for chemical, petroleum, petrochemical, pharmaceutical and other process industries. (44)

Glass Bonded Mica Insulation. General Electric Co., Chemical Div., Plastics Dept., 23 pp, illus. Manual on Mycalex, a glass bonded mica, for electronics and electrical design engineers. (45)

Laminated Metals. General Findings & Supply Co., Industrial Div., 6 pp, illus. Precious and other laminated metals, and fabricated precision parts and assemblies for the electronic, aircraft, automotive and allied industries. (46)

Synthetic Rubber. Goodyear Tire & Rubber Co., Chemical Div., 24 pp, illus. Shows types and applications of Pliolflex rubber and Pliolite latex, together with production and laboratory facilities. (47)

Custom Made Rubber Parts. Goshen Rubber Co., Inc., 8 pp, illus. Shows representative products, fabricating operations and development of compounds. (48)

Low Temperature Brazing. Handy & Harman, 4 pp, illus., No. 69. Applications of Easy-Flo shim and Easy-Flo wire. (49)

Bright Nickel Plating. Hanson-Van Winkle-Munning Co., 20 pp, illus. Technical instructions for the H-VW-M Nickel-Lume processes for bright nickel plating. (50)

Particle Accelerators. High Voltage Engineering Corp., 33 pp, illus., No. E. Survey of radiation machines and their use in chemical processing, sterilization and industrial research. (51)

Industrial Furnaces. A. F. Holden Co., 9 pp, illus. Drawings of gas and electric industrial furnaces. (52)

Magnetics. Indiana Steel Products Co., 6 pp, illus., vol. 4, no. 1. House organ devoted to applied magnetics. (53)

Piston Groove Inserts. International Nickel Co., Inc., 4 pp, illus. How maintenance costs are cut and service life of aluminum pistons is extended by use of piston groove inserts made of Ni-Resist austenitic iron. (54)

Pipe and Block Insulation. Johns-Manville, 12 pp, illus. Information on Thermobestos, a hydrous calcium silicate insulation for hot outdoor piping and process equipment operating at service temperatures up to 1200 F. (55)

Polyvinyl Chloride Linings. Kaykor Industries, Inc., 4 pp, illus. Discusses the three PVC linings most commonly used for stopping corrosion, and Fligid, a relatively flexible polyvinyl chloride laminate. (56)

Fluorocarbon Rubber. M. W. Kellogg Co., 16 pp, illus. Data on Kel-F Elastomer, a fluorocarbon rubber that has

Manufacturers' Literature

thermal stability up to 400 F and resists acids, ozone and other oxidants. (57)

Barrel Finishing. Lord Chemical Corp., 2068 So. Queen St., York, Pa., 44 pp, illus. Price 50¢. "The Lorco Method of Precision Barrel Finishing for Metals and Plastics" describes basic techniques, developed around a series of 27 chemical compounds that are used with or without fused alumina chips and other media. Write direct to Lord Chemical.

Plastic-Coated Wire Rope. Macwhyte Co., 2 pp, No. 5610. Specifications and information on proper use of plastic-coated wire rope. (58)

Magnesium Base Alloys. Magnesium Assn., 12 pp. "Magnesium Base Alloys, Alloy Nomenclature and Temper Designation" is an effort to arrive at a common system of alloy designation for use on prints and by purchasing agents. (59)

Localized Plating. Marlane Development Co., Inc., 13 pp, illus. Three articles from technical magazines describe the Dalic process of selective electroplating. Included are metallurgical characteristics of the plate, chemical characteristics of the solution, and a list of major applications. (60)

Heat Treating. Metal Treating Institute, 1 p. Proper ordering and specification procedures for firms purchasing heat treating services. (61)

Surface Measurement. Micrometrical Mfg. Co., 8 pp, illus. Technical data on surface measurement, the Profilometer and ASA Standard B46.1-1955. (62)

Fluoroscopic Investigations. North American Philips Co., 3 pp. Uses of a Norelco industrial image intensifier on steel and other metals with high density and absorption characteristics. (63)

Sprayed Ceramic Coatings. Norton Co., Refractories Div., 10 pp, illus., No. CP11.3. Consisting of hard, adherent, crystalline refractory oxides, Rokide spray coatings offer protection from high temperature and abrasion. Thermally and electrically insulating, they can be applied to metals and other materials. (64)

Rust and Paint Remover. Oakite Products, Inc., 2 pp. How Rustripper removes paint, phosphate coatings, rust and oil in one operation. (65)

Conversion Coating. Parker Rust Proof Co., 4 pp, illus. Use of nonmetallic Bonderite coating as a factory finishing procedure on tabulators, typewriters, furnaces and other products. (66)

Corrosion Proofing. Pennsylvania Salt Mfg. Co., 8 pp, illus. Corrosion proofing materials and techniques, including information on cement mortars, interliners for masonry construction, protective coatings and linings for surface treatment. (67)

Tooling Plastic. Ren Plastics, Inc., 8 pp, illus, Nos. 1001, 1003, 1004. Information on a dimensionally stable, thermosetting tooling plastic suitable for laminating or casting without heat or pressure. Also information on a laminating mix hardener, and on square and round glass-reinforced plastics tubing. (68)

Stampings. Republic Steel Corp., Pressed Steel Div., 16 pp, illus., No. ADV 681. Details extra facilities offered on contract stamping, and explains advantages of single source responsibility from iron ore to finished assembly. (69)

Acrylic Emulsion Copolymer. Rohm & Haas Co., 9 pp. Data on Acrysol ASE-75, an acrylic emulsion copolymer that converts quickly to a clear, viscous solution upon dilution and addition of a base. Applications requiring water-soluble polymers include thickening of latex, emulsions and other aqueous suspensions. (70)

Rust Prevention. Rust-Oleum Corp., 28 pp, illus., No. 255. How Rust-Oleum penetrates through rust to bare metals. Also featured are Galvinoleum coatings that can be applied over galvanized steel, aluminum and terne plate without etching to prevent excessive weathering. (71)

Chemical Resistant Pipe. Joseph T. Ryerson & Son, Inc., 6 pp, illus., No. 20-3. Rigid PVC pipe is resistant to salt solutions, acids, alkalies, sulfates, caustic solutions and bleaches. (72)

Small Wire. Secon Metals Corp., 2 pp. Research on and development and production of small precision wire. (73)

Surfactants. Foster D. Snell, Inc. How surfactants (surface active agents) can improve products and reduce processing costs. (74)

Corrosion Inhibitor. Solvay Process Div., Allied Chemical & Dye Corp., 17 pp, illus. Data on the use of sodium nitrite for rust and corrosion prevention. (75)

Industrial Glass Fabrics. J. P. Stevens & Co., Inc., 44 pp. Characteristics and properties of 68 industrial glass fabrics, including minimum breaking strengths. (76)

Steel Castings. Steel Founders' Society of America, 2 pp. Specification guide for ordering steel castings. (77)

Brass Pressure Die Castings. Titan Metal Mfg. Co., 4 pp, illus. Outlines most economical uses of brass pressure die castings as fabricated assembly parts. (78)

Wire Products. E. H. Titchener & Co., 17 pp, illus. Guide shows where round and flattened steel wire can be used in the design of metal products. (79)

Seamless Steel Tubing. Tube Reducing Corp., 9 pp, illus., No. R 9. Sizes, classifications, specifications and grades of Rockdrawn seamless steel tubing. (80)

Radioisotopes. Union Carbide Nuclear Co. Radioisotope catalog listing nearly 100 different radioactive preparations made and distributed by Oak Ridge National Laboratory. (81)

Blind Fastener. United Shoe Machinery Corp., 6 pp, illus. Shows use of Pop rivet on steel cabinets, door hardware, metal furniture and truck bodies. Also describes various riveting tools and interchangeable heads. (82)

Metal Bearings. U. S. Graphite Co., No. 18. Alloy selection, design and metallurgical requirements of Gramix sintered metal bearings. (83)

Metal Hose. Universal Metal Hose Co., 28 pp, illus., No. U-333. Data on seamless all-metal flexible pressure hose and spout tubing. (84)

Plastics. Westlake Plastics Co., 3 pp. Prices and specifications on methacrylate rod and tubing made by Lubo-Film extrusion and Liquo-Temp annealing processes. (85)

Abrasives. Wheelabrator Corp., 4 pp, illus., No. 901-D. Describes Steeletts, steel grit blast cleaning abrasive, for producing etched finishes on metal. (86)

Precision Glassware. Wilmad Glass Co., Inc., 4 pp, illus. Use of precision glassware for electronic applications. (87)

Other Available Literature

Irons and Steels • Parts • Forms

Stainless Fasteners. Allmetal Screw Products Co., Inc., 52 pp, illus. Indexed reference for 40 basic fastening devices, including engineering data on properties. (88)

Design Handbook for Stainless. Alloy Metal Wire Div., H. K. Porter Co., Inc., 38 pp, illus. Design information, applications, specifications and charts of mechanical, chemical and physical properties for stainless steel wire, rod and strip. (89)

Metal Powder Parts. American Sinterings Div. of Engineered Plastics, Inc., 4 pp, illus. Facilities for fabrication of ferrous or nonferrous metal powder parts. (90)

Stainless Fastenings. Anti-Corrosive Metal Products Co., Inc. Catalog with net prices and actual quantities in stock for stainless steel fastenings. (91)

Enameling Iron. Armco Steel Corp., 32 pp, illus. Describes sheet iron for porcelain enameling. Includes design and fabrication data and information on cleaning and pickling. (92)

Wire Parts, Small Stampings. Art Wire & Stamping Co., 4 pp, illus. Shows a variety of wire parts and small metal stampings produced in both ferrous and nonferrous metals. (93)

Low Alloy Steel. Bethlehem Steel Co., 66 pp, illus., No. 353. Properties and features of Mayari R steel for use in applications requiring high strength, good wear and corrosion resistance. (94)

Weldments. The Cleveland Welding Co. Illustrated brochure describes special

process of radial welding of circular steel parts. (95)

Circular Steel Shapes. Commercial Shearing & Stamping Co., 24 pp, illus., No. P-8. Covers company's range of cold formed circular steel blanks, flanged and dished shapes, produced from stocked dies. (96)

High Alloy Castings. The Cooper Alloy Co., 4 pp, illus., No. CC54. Pictorial analysis of production stages in producing stainless steel aircraft castings. (97)

Conveyor Belt Castings. Electro-Alloys Div., American Brake Shoe Co., 6 pp, illus., No. T-241. Design details and applications for Thermalloy conveyor belts. Folder emphasizes resistance to "crank-shafting." (99)

Investment Castings. Engineered Precision Casting Co., 8 pp, illus. Complete data on EpCo precision investment castings of stainless steel, alloy tool steel, beryllium-copper and most metals that can be melted. (100)

Wire. Keystone Steel & Wire Co., 12 pp, illus., No. 1a, Ke. Illustrates the various kinds of wire available and provides information about the cold heading operation. (101)

Stampings. Laminated Shim Co., Stampings Div., 12 pp, illus. Describes facilities for producing quality stampings to specifications. Also lists facts to be considered in ordering stampings. (102)

Cold Finished Steel. LaSalle Steel Co., 32 pp, No. 6. Dictionary contains definitions frequently used in purchase, manufacture, treating, machining and finishing of steel. Includes standard grain sizes for steels and method of determining hardenability. (103)

Malleable Iron. Malleable Founders' Society, 4 pp, illus., No. 52. New facts on the uses of malleable iron. (104)

Quality Controlled Iron. Meehanite Metal Corp., 12 pp, illus. Applications of Meehanite in cams, camshafts and crankshafts. (105)

Threaded Stampings. Mohawk Mfg. Co., 2 pp, No. 851. Illustrates variety of products produced by Mohawk's stamping processes, guaranteeing uniform threaded parts with uniformly threaded holes. (106)

Forgings. Pittsburgh Forgings Co., 4 pp, illus. Pictures types of forgings made for railroad freight cars. (109)

Seamless Mechanical Tubing. Pittsburgh Steel Co., 198 pp, illus. Applications, cost analysis, production techniques, inspection and testing methods, tolerances, chemical composition, physical properties, machining techniques, refence tables for full range of seamless mechanical tubing. (110)

Metal Powder Parts. Powdered Metal Products Div., Yale & Towne Mfg. Co., 6 pp, illus., No. 352. Shows a variety of ferrous and nonferrous metal powder parts fabricated by this company. (111)

Metal Containers. Pressed Steel Tank Co., 16 pp, illus. Tells how many industries have been helped in quality production at low cost by use of Hackney Metal containers and deep drawn component parts. (112)

Roll Formed Shapes. Roll Formed Products Co., 26 pp, illus. Contains drawings and dimensions of 100 complex and simple shapes and reference charts for dimensions. (113)

Zinc Coated Steel. Sharon Steel Corp., 12 pp, illus. Physical properties of hot-dipped, zinc-coated, strip steel. (145)

Forged Steel Rings and Flanges. Standard Steel Works Div., Baldwin Lima-Hamilton Corp., 12 pp, No. 10,000. Discusses design advantages and cost-cutting applications of forgings in industrial processing equipment. (146)

Powder Metallurgy. F. J. Stokes Machine Co., 36 pp, illus. Clear, concise discussion of powder metallurgy including summary of process, applications, mechanical characteristics of powder metal parts, and design considerations. (147)

Malleable and Alloy Iron Castings. Texas Foundries, Inc., 20 pp, illus. Describes foundry facilities and provides case histories of applications of malleable iron. (148)

Small Precision Metal Parts. Torrington Co., 4 pp, illus. Illustrates the various small precision metal parts custom-made by the Specialties Div. (149)

Constructional Alloy Steel. U. S. Steel Corp., illus. "U. S. Steel Presents T-1" gives properties and fabrication data for new high strength weldable steel with exceptional toughness (150)

Alloy Steel Castings. Unitcast Corp., 2 pp. Specifications, characteristics and uses of T-loy 42, alloy steel castings. (151)

Ferro-Alloys and Metals. Vanadium Corp. of America, 24 pp, illus. "The Vancoram Review" presents technical articles on applications and developments in ferro metallurgy especially concerned with vanadium alloys. (152)

Pipe and Tubing. The Wallingford Steel Co., 8 pp, illus. Stainless, carbon and alloy steel tubing for ornamental, mechanical, pressure, sanitary and aircraft use in size range from ¼-in. to 3-in. o.d. (154)

Stainless Steel Sheet, Strip. Washington Steel Corp., 4 pp. Types, uses, physical properties and specifications of Mico-Rold stainless steel sheet and strip. (156)

Stampings. Well Specialty Co., Inc., 22 pp, illus. Facilities for stampings, dies and engineering service. (157)

Metal Stamping. Worcester Pressed Steel Co., 8 pp, illus. Describes facilities for custom metal stamping. (159)

Mechanical Tubing. Youngstown Sheet & Tube Co., 4 pp, illus. Features size and wall thickness of a complete line of Yoloy electric weld mechanical tubing. (160)

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Nonferrous Metals • Parts • Forms

Die Castings. Advance Tool & Die Casting Co., 8 pp, illus. Illustrates facilities for producing die castings to specifications. (162)

Machining Copper. American Brass Co., 32 pp, illus., No. B-3. Suggestions for machining copper, brass, bronze and nickel silver, including tool rakes, clearances, cutting speeds and feeds. Tables give physical properties and specifications for Anaconda metals and alloys. (163)

Electrolytic Copper Powders. American Metal Co., Ltd., 3 pp. Data sheets on specifications for electrolytic copper powders. (164)

Engineering Bronzes. American Crucible Products Co., 12 pp, illus. Includes complete data on facilities, technical information, case histories and applications of Promet bronzes. (165)

Titanium Foil. American Silver Co., Inc., Technical Data Sheet No. 100. Thin gaged, commercially pure titanium foil rolled to close tolerance. Includes tolerance chart, mill limits, mechanical and electrical properties, and suggested applications. (167)

Investment Castings. Austenal Laboratories, Inc., 12 pp, illus. Describes Microcast process and charts representative properties of investment cast alloys. (168)

Magnesium, Aluminum Castings. Bendix Foundries, 4 pp. Facilities for producing sand, die, shell, plaster and permanent mold castings of magnesium or aluminum. (169)

Beryllium Alloys. Beryllium Corp., 20 pp, illus. The uses of beryllium and its alloys. (170)

Duplex Tubing. Bridgeport Brass Co., 14 pp, illus., No. 1954. Explains use of Duplex tubes for heat exchangers and condensers in which internal and external corrosion conditions differ. (171)

Sintered Bronze. Bunting Brass & Bronze Co. 12 pp, illus., 56P. Information on stock bearings, flange stock bearings, washers and bars made of sintered bronze. (172)

Precision Investment Castings. Crucible Steel Co. of America, 16 pp, illus. How to precision-cast unmachinable high-temperature alloys to close tolerances through "lost wax" method. (173)

Static and Centrifugal Castings. Duraloy Co., 16 pp, illus., No. 3354-G. Describes facilities for producing high alloy static and centrifugal castings. Engineering data on castings for heat, corrosion and abrasion resistance. (174)

Magnesium, Aluminum Castings. Eclipse-Pioneer Div. Foundries. "Book of Facts" shows company's facilities for custom-making aluminum and magnesium castings. (175)

Nonferrous Alloy. Elgin National Watch Co., Abrasives Div., 2 pp. Corrosion resistant data and other characteristics of Elgiloy corrosion- and fatigue-resistant alloys. (176)

Aluminum Bronzes. Fansteel Metallurgical Corp., Technical Data Bull. No. 15.100. Eighteen grades of aluminum bronze available in centrifugal, perma-

nent mold and sand castings. Properties and applications. (177)

Aluminum Alloys. Peter A. Frasse & Co., Inc., 4 pp, illus. General properties, fabricating characteristics, typical applications and available size ranges of nine common aluminum alloys. (178)

Electroforming. Gar Precision Parts, Inc., 4 pp, illus. Process permits exact reproduction of intricate details on sheet or complex forms using permanent or expendable mandrels. (179)

Metal Powders. The Glidden Co., 6 pp. Contains specification sheet for lead and Resistox copper powders. (180)

Investment Castings. Gray-Syracuse, Inc., 4 pp, illus. Parts of precision-cast brass, bronze, beryllium copper and steel. (181)

Nickel-Base Alloys. Haynes Stellite Div., Union Carbide & Carbon Corp., 40 pp. Properties, specifications and uses of Hastelloy corrosion resistant grades. (182)

Beryllium Copper Springs. Instrument Specialties Co., Inc., 16 pp, illus., No. 9. Catalog of compression springs, flat springs, strip springs, contact strips and contact rings. (183)

Investment Castings. Investment Casting Co., 12 pp, illus. Second edition explains how investment casting is used to eliminate machining and assembly costs and minimize waste metal. (184)

Rare Earths. Lindsay Chemical Co., 12 pp, illus. Describes company's work in the rare earth field. (187)

Lithium Metals, Compounds. Lithium Corp. of America. Data sheets on properties and uses of lithium metal and organic and inorganic lithium compounds for metal treatment, ceramic modifications and welding. (188)

Machining Titanium. Mallory-Sharon Titanium Corp., 8 pp, illus. Machining recommendations for titanium and titanium alloys. Specific information on turning, milling, tapping and grinding. (190)

Nonferrous Castings. Monarch Aluminum Mfg. Co., 4 pp, illus. Describes permanent mold castings made by new process to give high, dense finish of great durability. (191)

Nonferrous Powder Parts. New Jersey Zinc Co., 4 pp, illus. Advantages of nonferrous powder parts in product engineering with emphasis on brass powder parts. (192)

Precision Castings. Ohio Precision Castings, Inc., 12 pp, illus. Numerous examples of industrial applications of this company's brass, bronze, aluminum and beryllium copper plaster mold castings. (193)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp, illus. Describes Phoenixspun methods for spinning spherical and extra deep-drawn contours. (194)

Die Castings. Precision Castings Co., Inc., 24 pp, illus. Describes company's integrated facilities for quantity production of aluminum, magnesium and zinc die castings. (195)

Aluminum Extrusions. Precision Extrusions, 12 pp, illus. Describes aluminum extrusion process. Tables of physical properties and recommended applications. (196)

Titanium and Its Alloys. Republic Steel Corp., 32 pp, illus., No. 588. A practical working manual presenting some basic and fairly well substantiated data on commercial quality titanium and its alloys. (197)

Aluminum Appliance Parts. Reynolds Metals Co., 20 pp, illus. Discusses use of aluminum parts in appliances such as refrigerators, air conditioners, washers and dryers. (198)

Zinc Die Castings. St. Joseph Lead Co., 24 pp, illus. Discusses role of zinc as a base metal for die casting alloys and lists the variety of commercial finishes for zinc base die castings. (199)

Centrifugal Castings. Sandusky Foundry & Machine Co., 6 pp, illus. Specification chart for ferrous and nonferrous alloys for centrifugal castings. (200)

Precision Investment Casting. Alexander Saunders & Co., 14 pp, illus. Discussion of advantages of this process in comparison with conventional methods of production, techniques, equipment and supplies needed. (201)

Bi-Metallic Construction. Arthur Tickle Engineering Works, 8 pp, illus. Description of Alumibond process for molecularly bonding aluminum and its alloys to iron and steel and their alloys. (202)

Aluminum Wire. U. S. Rubber Co., 30 pp, tables. A handbook on the uses and properties of aluminum for power and lighting wire. (204)

Finned Tubing. Wolverine Tube Co., 1 p. Sample of Wolverine Trufin integral-finned tube for heat transfer equipment and other uses. (206)

Light Metal Forgings. Wyman-Gordon Products Corp., 4 pp, illus. Announces the availability of large-size light alloy forgings, particularly those of magnesium and 7075 aluminum. (207)

Nonmetallic Materials • Parts • Forms

Silicone Rubber. Acushnet Process Co., 8 pp, illus., No. B. Describes method of custom-compounding silicone rubber. Gives property ratings, molding techniques, mold design and design specifications. (209)

Felt Parts. American Felt Co., folder, illus. Describes custom-made cut felt parts and applications, including separating, protecting, sealing, polishing and insulation. (210)

Flexible Tubing. American Hard Rubber Co., 4 pp, illus., No. 66-D. Physical properties, chemical resistance, standard sizes and characteristics of transparent plastic tubing. (211)

Extruded Plastics. Anchor Plastics Co. 12 pp, illus. Applications of the thermoplastic rods, tubes and shapes. Summary of properties of plastics materials with usage table. (212)

Reinforced Silicone Rubber. Arrowhead Rubber Co., 18 pp, illus., No. S-11. Technical data on Arcosil 2184, a fiberglass fabric impregnated with silicone rubber. Material has wide temperature range, high strength and flexibility. (213)

Epoxy Resins, Hardeners. Bakelite Co., 16 pp, illus. Describes use of epoxy resins for tools, dies, jigs, adhesives, etc. Separate section devoted to release agents for molds. (214)

Polyester Resins. Barrett Div., Allied Chemical & Dye Corp., 14 pp. Technical data reports 55-1 through 55-12. Properties of rigid, flexible and resilient types of Plaskon polyester resins. (215)

Super Refractories. The Carborundum Co., 22 pp, illus., No. 5056. Silicon carbide, mullite aluminum oxide, and alumina refractories and cements, with applications and properties. (216)

Polyester Resins. Celanese Corp. of America, Plastics Div., 22 pp, illus. Provides background information, properties, curing processes, formulations and instructions for laminating, casting, spraying and impregnating with the MR series, low pressure, liquid thermosetting resins. (217)

Compounded Elastomers. Chicago Rawhide Mfg. Co., 32 pp, illus. Characteristics, properties and engineering applications of Sirvene compounded elastomers. (218)

Thermoplastic. Colonial Plastics Mfg. Co., Industrial Div., 16 pp. Technical data on properties, available forms, fabrication and applications of Lucoflex, a rigid polyvinyl chloride. (220)

Coated Fabrics. Connecticut Hard Rubber Co. Uses; chemical, electrical and mechanical properties; and availability of heat resistant, silicone rubber-coated glass fabrics. (221)

Vulcanized Fibre. Continental-Diamond Fibre Co., 12 pp, illus., No. DVF-55. Complete physical, chemical and electrical properties and other engineering data for vulcanized fibre parts, sheets, tubes and rods. (222)

Barrier Materials. Dobeckmun Co., 4 pp, illus. Flexible packaging materials: combinations of polyethylene, Kraft paper, vinyl, aluminum foil, wax. (223)

Plastic Film. E. I. du Pont de Nemours & Co., Film Dept. 8 pp, illus. Latest commercial uses and detailed physical and chemical properties of Mylar. (224)

Industrial Textile Fibers. E. I. du Pont de Nemours & Co., Inc., Textile Fibers Dept., 20 pp. Consideration of synthetic fibers as industrial materials. Includes rayon, acetate, nylon, Orlon, Dacron and Teflon fibers. (225)

Felt. The Felters Co., 22 pp. Design properties, selection and applications of felt and felt products. (226)

Laminated Plastics Service. The Formica Co., 6 pp, illus. Describes customer service in research and fabricating for both custom and standard grades. (227)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 67 and 68

Electrical Insulating Materials. General Electric Co., 8 pp, illus. Lists insulating materials, including varnishes, finishes and mica mat. Properties and applications given. (228)

Rubber Mountings and Bushings. General Tire & Rubber Co., Industrial Products Div., 12 pp, illus., No. 701. Rubber-core mountings and bushings for vibration-isolation and oscillatory-motion bearings. (229)

Vinyl Tubing. Gering Products, Inc., 4 pp, illus. Folder on Ger-Flex, a transparent, nontoxic, vinyl plastic flexible tubing that cannot corrode. (230)

Plastics Stamping. B. F. Goodrich Chemical Co., 7 pp, illus. How to form rigid vinyl plastic parts with metal stamping presses and Geon resins. (231)

Graphite. Graphite Specialties Corp., 4 pp, No. GS 101-1. An impervious graphite, more than 99.5% pure carbon, for high temperature parts. Chemical resistance data and physical properties including heat effects to 5700 F. (232)

Structural Honeycomb. Hexcel Products Co., 32 pp, illus., No. C. Technical data on aluminum, glass fabric, stainless steel and cotton fabric honeycomb core for sandwich construction. (233)

Electrical Insulation. Irvington Varnish & Insulator Div., Minnesota Mining & Mfg. Co., Irvington, N. J. Loose-leaf binder catalog of flexible electrical insulation materials. Includes charts and conversion tables. Write direct to Irvington on company letterhead.

Standard Bearing Sizes. Keystone Carbon Co., 30 pp. Dimensions and ordering code numbers for more than 1000 metal commercial bearing sizes. Includes sizes for sleeve, flange, double and single hub spherical type bearings and thrust washers. (234)

Foam Polystyrene. Koppers Co., Inc., 10 pp, No. C-4-200-T. Describes expandable polystyrene beads and polystyrene foam. Includes physical and chemical properties, suggested applications, molding data and instructions for use of adhesives with the material. (235)

Rubber Design Handbook. Lavelle Rubber Co., 80 pp, illus., No. MT-56. Basic facts pertaining to the design of custom-made rubber and rubber-like articles are given in this thumb indexed handbook, together with actual samples of products. (237)

Silicones. Linde Air Products Co., 4 pp. A catalog of principal silicones, silicone intermediates and silicone monomers sold by Linde. (238)

Hardboards. Masonite Corp., 24 pp, illus., No. 1d/2. Properties and advantages of Preswood and other Masonite hardboards, and their relation to product design. (239)

Refractory Porcelain. McDanel Refractory Porcelain Co., 36 pp, illus. Catalog of high temperature porcelain products with physical, mechanical and electrical properties. (240)

Insulating Material. Mica Insulator Co. Catalog of standard electrical insulating materials. (242)

Carbon Specialties. Morganite, Inc., 12 pp, illus. Design data reference for carbon specialties, including chemical and physical properties, and typical blank sizes and parts. (243)

Glass Bonded Mica. Mycalex Corp. of America, 24 pp, illus. Design information for parts to be machined from glass bonded mica. (244)

Cathode Protection. National Carbon Co., 12 pp, illus., No. S-6500. How to mitigate corrosion of underground and submerged metal structures by application of an impressed current cathodic protection system using graphite anodes. (245)

Plastics Pipe. National Tube Div., U. S. Steel Corp., 28 pp, illus., No. 24. Data on unplasticized rigid polyvinyl chloride pipe, both normal and high impact types. Describes installation techniques. (246)

Vulcanized Fibre. National Vulcanized Fibre Co., 18 pp, illus. How vulcanized fibre is made; its outstanding properties; shapes and grades available; and typical applications. (247)

Synthetic Rubber. Naugatuck Chemical Div., U. S. Rubber Co., 8 pp, illus. Describes eight synthetic rubber latex materials and lists the uses for which each was developed. (248)

Foamed Plastic. Nopco Chemical Co. Suggested application of Nopco-foam, a flexible foamed plastic. (249)

Carbon Parts. Ohio Carbon Co., 4 pp, illus. Gives thermal, mechanical and electro-mechanical properties of company's carbon parts. (250)

Fiber Glass. Pittsburgh Plate Glass Co., 4 pp, illus. Advantages of using glass fiber for sound and heat insulation applications. (251)

Carbon Graphite. Pure Carbon Co., Inc., 32 pp, illus., No. 52. Technical data giving properties, applications and specifications of Purebon carbon graphite. (252)

Plastics Sheets, Tubing. Pyramid Plastics, Inc. Price list and data on plastics tubing, pipe, rod, sheets and fittings. (253)

Polyester Resins. Reichhold Chemicals, Inc. Brochure includes 11 technical bulletins, two to six pages long, describing the Polylite line of liquid thermosetting polyester resins. The bulletins cover molding characteristics and physical properties of ten resins of various heat- and light-resistant grades, suitable for use in glass fiber reinforced applications. (254)

Laminated Teflon Pipe. Resistoflex Corp., 4 pp, illus. Woven glass impregnated with Teflon resin makes pipe for working pressures to 300 psi. Physical and chemical properties given. (255)

Vulcanized Fibre Products. Spaulding Fibre Co., 36 pp, illus. Vulcanized fibre sheets, rods and tubes; fabricated parts; electrical insulating materials; laminated thermosetting plastics; motor insulation; fibre board and transformer board. Physical, mechanical and electrical properties of all materials in chart form. (256)

Steatite Ceramic. Star Porcelain Co., 1 p, No. 600. Standard ways of insulating washers and bushings of steatite for high temperature insulation applications. (257)

Reinforced Plastics. Strick Plastics Corp., 4 pp, illus. Describes reinforced polyester laminate with good thermal, electrical, chemical and mechanical properties. Typical applications given. (258)

Pipe Fittings, Flanges. Tube Turns Plastics, Inc., 12 pp, illus. Drawings and data on fittings and flanges made of unplasticized polyvinyl chloride. (260)

Rubber Engineering Data. Tyer Rubber Co. Illustrates molded and extruded rubber products and provides technical specifications and relative properties of natural rubber, Buna S, Buna N, neoprene, butyl, thiokol and silicone. (261)

Metal Plywood Laminate. United States Plywood Corp., 8 pp, illus. Gives special features, advantages and wide variety of uses for Armoply, sheet metal-bonded plywood. (262)

Tetrafluoroethylene. U. S. Gasket Co., No. 300. Tables and descriptive matter on chemical, electrical, thermal and mechanical properties of Teflon. (263)

Nylon Screws. Weckesser Co., 3 pp, illus. Describes black nylon screws and nuts and use in design problems. Gives price list for various types. (264)

Industrial Fibers, Textiles. Wellington Sears Co., 26 pp, illus. Properties of industrial textile fibers, including cotton, rayon, acetate, nylon, acrylic, polyester, glass, vinyl and protein. Defines yarn designations basic weaves and variations as used in fabrics. How fabrics are selected for use with rubber; as coated fabrics; in laminated plastics; for filtration purposes; and in other applications. (265)

Laminated Plastics. Westinghouse Electric Corp., 50 pp. Catalog on industrial Micarta covering all grades and forms in which it is supplied, and the chemical, mechanical and electrical properties of each. Machining data given. (267)

Finishes • Cleaning and Finishing

Barrel Finishing. The Abbott Ball Co., 8 pp, illus. Describes barrel finishing techniques with a new design tumbling barrel. (269)

Aluminum Finishes. Aluminum Co. of America, 48 pp, illus. Discusses methods in which appearance and performance characteristics of aluminum may be changed. Factors covered include texture, reflection, durability and surface hardness. Finishing methods and applications of specific finishes to products and structures are given. (270)

Hot Dip Galvanized Coatings. American Hot Dip Galvanizer's Assn., Inc., 16 pp, illus. Description of hot dip galvanizing process in industrial and consumer applications. (271)

Plastics Finish. John L. Armitage & Co., 8 pp. Information on Armorhide, a textured plastic resembling leather. (272)

Spray Painting. Conforming Matrix Corp., 5 pp, illus. Gives description, uses, and advantages of this firm's spraying masks, mask washing machine and spray painting equipment. (273)

Vapor-Spray Degreasers. Detrex Corp., 4 pp, illus. Open top degreasers for

Manufacturers' Literature

pure vapor degreasing, spray flushing with oil-free solvent distillate and final pure rinse. (274)

Black Oxide Finish. Du-Lite Chemical Corp. How Du-Lite finishes can be used for any steel blackening problem. Also information on Du-Lite cleaner, strippers and burnishing compounds. (275)

Air Dry Lubricant. Electrofilm Corp., 4 pp, illus. Complete data on Lubro-bond, a dry film lubricating compound specifically designed to meet the anti-friction requirements of industry. (276)

Solution Coating Resin. Firestone Plastics Co., 8 pp, No. 13. Properties and uses of Exon 450 vinyl chloride copolymer resin for solution coatings, either permanent or strippable. (277)

Chemical Resistant Coatings. McDougall-Butler Co., Inc., 4 pp, illus. Describes chemical resistant coating used without primer on metal and wood surfaces. (278)

Enamel. Maas & Waldstein Co., 2 pp, No. 520. Data sheet for industrial multicolored enamels. (279)

Silicone-Base Finish. Midland Industrial Finishes Co. Brochure describes silicone-base finish. said to resist heat at 500 F without discoloration. (280)

Barrel Finishing. Minnesota Mining & Mfg. Co., 12 pp, illus. How barrel finishing works, when to use it, and what operations barrel finishing performs. Supplementary booklet discusses abrasive chips and compounds for barrel finishing. (281)

Micropolishing. The Murray-Way Corp. Engineering specifications and auxiliary equipment needed for micropolishing. (282)

Primers. Neilson Chemical Co., 4 pp, No. 55-133. Describes Lyfanite coatings, corrosion, resistant phosphate coatings for aluminum, ferrous alloys and other metal surfaces. (283)

Metal Cleaner. Niagara Alkali Co. Pamphlet gives properties of Nialk Trichlorethylene, high quality metal-cleaning and degreasing agent. (284)

Blast Cleaning and Dust Control. Pangborn Corp., No. 227. Describes Roto-blast equipment designed for blast cleaning of castings, forgings and heat treated parts. Emphasizes features of Rotoblast wheel. (286)

Paint Spray. Ransburg Electrocoating Corp., 16 pp, illus. Electrostatic spray paint process for automatic industrial applications. (287)

Porous Chromium Coatings. Van der Horst Corp. of America, 12 pp, illus. Describes an oil-retaining, wear resistant chromium coating for bearing surfaces, cylinder walls and other applications where hard wear and lubrication are factors. (288)

Methods and Equipment

Induction Furnaces. Ajax Electrothermic Corp., 8 pp, illus. No. 27-B. Induction furnaces for precision melting, heating forging billets, and heat treating. Includes selector chart for induction heating and melting applications. (291)

Gasket Materials. Armstrong Cork Co., 24 pp, illus. Complete data on various cork and rubber gasket materials made to meet government specifications. (292)

Epoxy Resin Adhesives. Armstrong Products Co., 16 pp. Prices and technical data on adhesives having high tensile shear strengths. Information on a new line of epoxy resin formulations with low shrinkage and good electrical properties. (293)

Industrial Radiography. Atomic Energy of Canada, Ltd., Commercial Products Div. Up-to-date information on nondestructive testing of metals by gamma radiography. (294)

Echelle Spectrographs. Bausch & Lomb, 23 pp, illus. Catalog shows how the echelle type spectrograph works, what it does and the instrumentation available. (295)

Coated Abrasives. Behr-Manning Corp., 60 pp, illus. Compilation of technical papers on coated abrasive grinding and polishing techniques. Covers coated abrasives theory and practice, contour polishing and grinding, part sizing and deburring. (296)

Black Light. Black Light Corp. of America, 65 pp, illus. Long wave ultraviolet light for display, industrial inspection and flaw detection. Case histories plus data on research in this field. (297)

Chromium-Molybdenum Electrodes. Champion Rivet Co., 11 pp, plus graphs. New welding electrodes for chromium-molybdenum alloy steels. Complete welding data includes physical properties, chemical analyses of weld deposits, mechanical properties and welding technique analysis. (298)

Projection Gaging. Eastman Kodak Co., 12 pp, illus. Describes four models of the contour projector and their accessories for inspection usage. (300)

Electric Sintering Furnaces. The Electric Furnace Co., 4 pp, illus. Descriptions of nine sintering furnaces. (301)

Fasteners. H. M. Harper Co., 8 pp, illus., vol. 19, no. 2. Various case histories of applications of Harper's fasteners, emphasizing corrosion-resistant bolts. (303)

Furnaces. C. I. Hayes, Inc., 44 pp, illus., No. 112. Complete data on a variety of furnaces for hardening, tempering, carbonitriding, forge heating, sintering, annealing and tool heat treating, as well as on atmosphere generators and ammonia dissociators (304)

Heat-Treating Furnaces. Hevi Duty Electric Co., 8 pp, illus., No. 653. Describes furnaces for annealing, stress relieving and nitriding. (305)

Pyrometers. Illinois Testing Labs Inc., 6 pp, illus. Thermoelectric pyrometer for precision measurements of temperatures beyond 1000 F. (306)

Atmosphere Control. Leeds & Northrup Co., 20 pp, illus., No. TD4-620(1). How to control surface carbon content automatically in heat-treating steel. (307)

Tubular Furnaces. Marshall Products Co., 4 pp, illus. Discusses both the creep test and tensile test models of Marshall tubular furnaces, as well as control panels and radial brackets. Includes specifications. (308)

Furnace and Oven Controls. Minneapolis-Honeywell Regulator Co., 44 pp, illus., No. 54-1. Catalog and price list on Brown instruments and Honeywell controls for industrial furnace and oven equipment. (309)

Induction Brazing. The Ohio Crankshaft Co. "Typical Results of Tocco Induction Brazing and Soldering" shows by case histories the advantages of these fastening methods. (310)

Surface Pyrometer. Pyrometer Instrument Co., Inc., 6 pp, illus., No. 168. Complete data on the Pyro surface pyrometer for quick and accurate surface and sub-surface temperature readings. (311)

Cold Cabinet. Revco, Inc., 2 pp. Low temperature cabinet for industrial processes and research. (312)

Hardness Testers. Riehle Testing Machines, Div. of American Machine & Metals, Inc., 4 pp, illus., No. RH-1154. Portable hardness testers for Rockwell readings with scales A, B, C, D, F and G. (313)

Screws. Russell, Burdsall & Ward Bolt & Nut Co., 8 pp, illus. Presents principle of fastening, advantages and specifications of a complete line of Spin-Lock screws available in hex, pan, truss or flat heads. (314)

Set Screws. Set Screw & Mfg. Co., 24 pp, No. 19. Lists prices and dimensional information. (315)

Fasteners. Simmons Fasteners Corp., 36 pp, illus., No. 1252. Detailed information on Dual-Lock, Link-Lock, Quick-Lock, Roto-Lock and Spring-Lock fasteners. (316)

Heat Treating Equipment. Stanwood Corp., 4 pp. Brief description of types of heat treating equipment with suggested applications. (317)

Tool, Dies, Plastics Molds. Sylvania Electric Products, Inc., 11 pp, illus. Describes facilities for design, engineering and manufacture of tools, dies and molds for plastics. (318)

Preheat Temperatures. Tempil Corp. Chart lists recommended preheat temperatures for 79 commonly used metals and alloys. (319)

Electric Furnaces, Controls. Thermo Electric Mfg. Co., 20 pp, illus., No. 55. Electric furnaces, temperature controllers and hot plates for industrial use. (320)

Brazing Alloys. United Wire & Supply Co., 3 pp, illus. Wire brazing aluminum for low temperature brazing of various metals and alloys. (321)

Welding Process. Westinghouse Electric Corp., 7 pp, No. B-6525. Performance and applications of consumable electrode inert gas welding process. (322)

Hardness Testers. Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc. Engineering data, uses and design features of Rockwell hardness testers. (323)

Heating Units. Edwin L. Wiegand Co., No. 50. Catalog of industrial heating units with specifications and features. (324)

Cold Roll Forming. The Yoder Co., 88 pp, illus. Designed as a text or reference book on the function, scope and economies of cold-roll forming. (325)

One point of view

Materials Inspire Designs

Which comes first, the design or the material? Unlike the "chicken - or - the - egg" riddle, this question can be answered, but the answer is not always the same. A common answer is that the design naturally comes first. And it would appear more logical that a design or product must be conceived first and then materials found to embody the design. This order of things is certainly true in many cases. But it is also true that materials themselves stimulate designs and products.

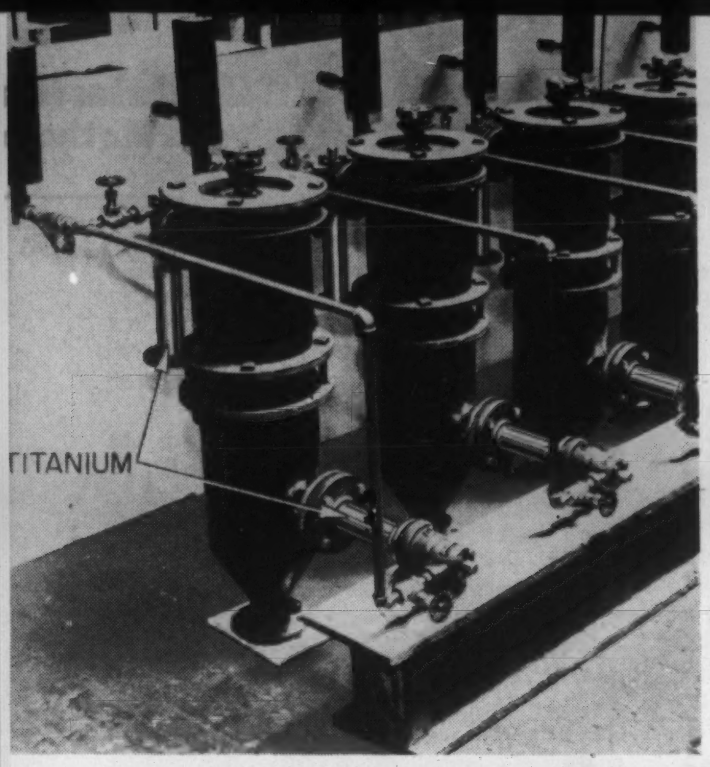
The late Dr. Lester referred to this creative function as the "inspirational aspect of materials." It has always been indispensable to the development of civilization. It was the stimulus that led to many of man's earliest inventions. The cutting property of sharp stones, for example, most likely led to the development of knives and weapons. And the compass certainly must have been inspired by the magnetic properties of the lodestone.

Today, this little recognized creative function of materials continues to foster new designs and products. The unique electrical properties of germanium and other semiconductor materials led to the development of transistors; the porous nature of metal powder parts led to the oilless bearing; the piezoelectric properties of quartz crystals gave rise to a large family of electronic devices.

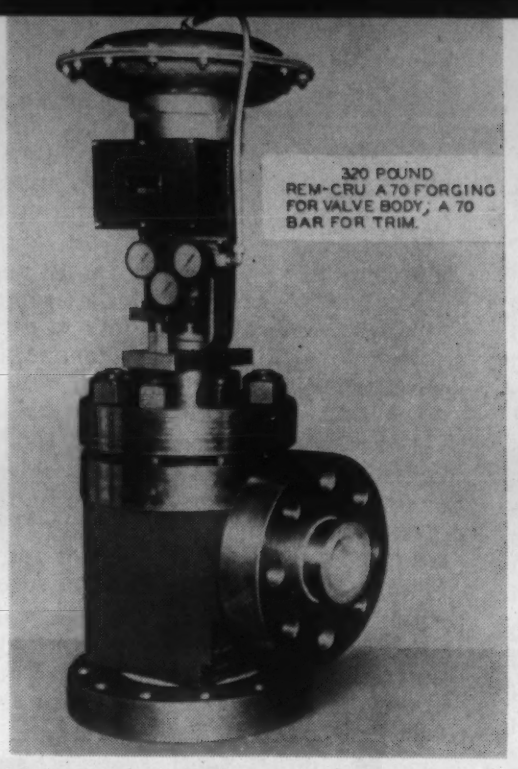
Despite the fact that materials themselves have always inspired new designs and products, the tendency of industry has been to underestimate the importance of materials' creative role. Traditionally, producers have concentrated on developing materials to meet specific applications or requirements. This approach must, of course, continue to be used. But the approach which we are discussing here also has its place and should not be neglected.

It is encouraging to note that a growing number of companies are again recognizing the importance of spending time and money on developing materials, not for any known present use, but for the future. One company, for example, is engaged in developing and studying ultra-high purity metals. In the case of vanadium metal, they have investigated its unique electrical property, namely, that the coefficient of resistance changes linearly with temperature. They are confident that this unusual characteristic will lead to new designs, new devices and new mechanisms.

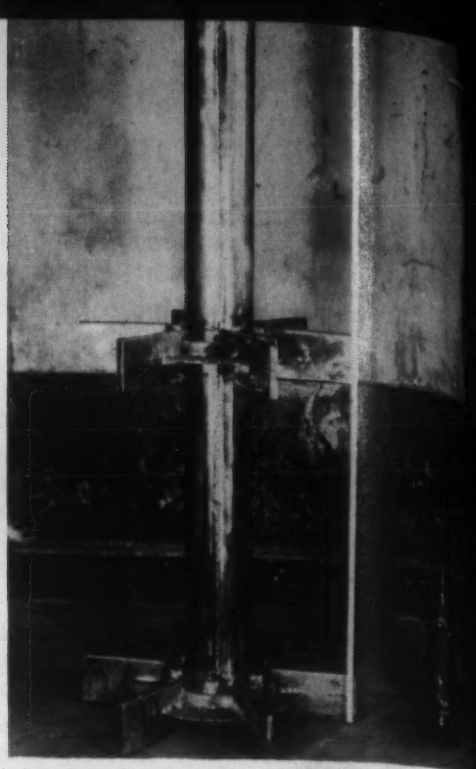
It is to be hoped that many more organizations, including the universities and research institutions, will devote a greater share of their energies to developing materials which, although not immediately useful, are capable of inspiring new and better designs in the future.



Steam jet assemblies, *Du Pont's Pigments Dept., are subject to corrosion by high velocity steam and dilute hydrochloric acid. Cast iron steam jet diffusers had to be replaced every 3 mo.*



Titanium valve *has a 2700 psi pressure drop. Stainless steel valve used in the same application lost control after 70 hr. This valve operated 1680 hr without overhauling, an increase of 24 times.*



Impeller *used by Calera Mining Co. for cobalt recovery operation. Titanium impeller, left, operates in an autoclave, right, with 10-25% sulfuric acid solution at 600 psi and 400 F.*

Where Industry Is Using Titanium

■ The use of titanium for its strength-weight properties in military aircraft is well known. Looking to the future, these same properties will help trim weight and increase payload in all types of civilian aircraft. But apart from the aircraft industry, titanium can make a real contribution to American industry, particularly for companies plagued by serious corrosion losses.

Titanium sheet currently sells for about $15.00 per lb. A price level of $2.00 to $5.00 per lb has been forecast in five to ten years. But even at today's titanium prices, many present industrial applications are economically sound.

Chemical applications

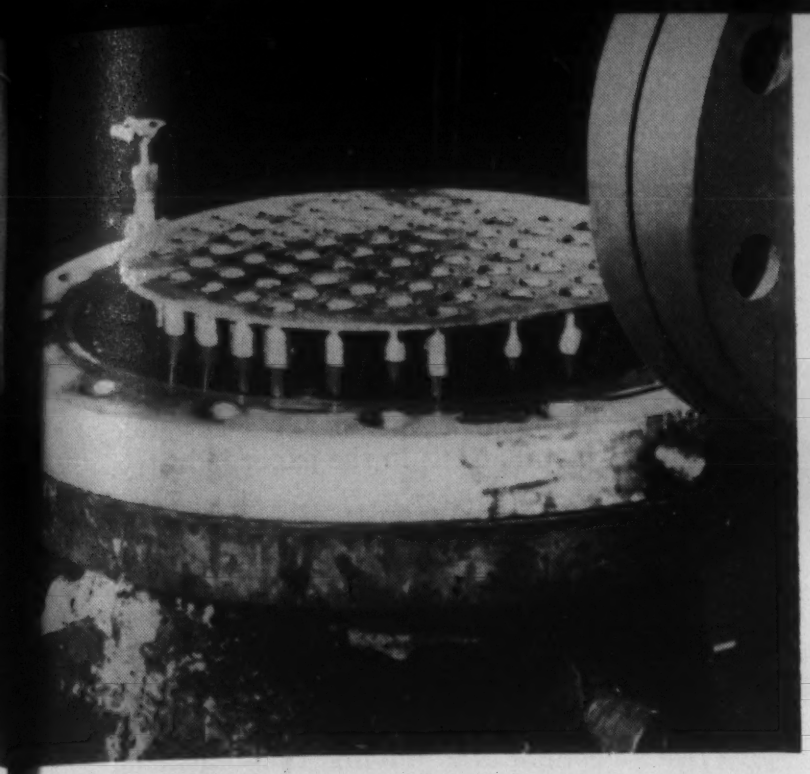
In the chemical industry titanium has proved its value in a Minneapolis - Honeywell titanium valve. This valve, machined from a commercial (A-70) titanium forging, resists a corrosive and erosive fluid flowing at high velocity. The inlet pressure is 3000 psi and there is a 2700 psi pressure drop across the valve. A stainless steel valve previously used lost control after 70 hr service. This valve, shown in the accompanying photograph, operated 1680 hr without overhauling, an increase of 24 times.

In a manufacturing process at the Pigments Department of E. I. du Pont de Nemours, steam jet assemblies are used to create process vacuum. They are subject to corrosion by high velocity steam and dilute hydrochloric acid. Original diffusers made of cast iron had to be replaced every three months. Du Pont engineers tried a variety of corrosion resisting metals, including bronzes and special purpose alloys without success. Titanium steam jet diffusers—indicated by arrows in the photograph—were put into service two and a half years ago. They are still operating and have given continuous trouble-free operation with no sign of corrosion.

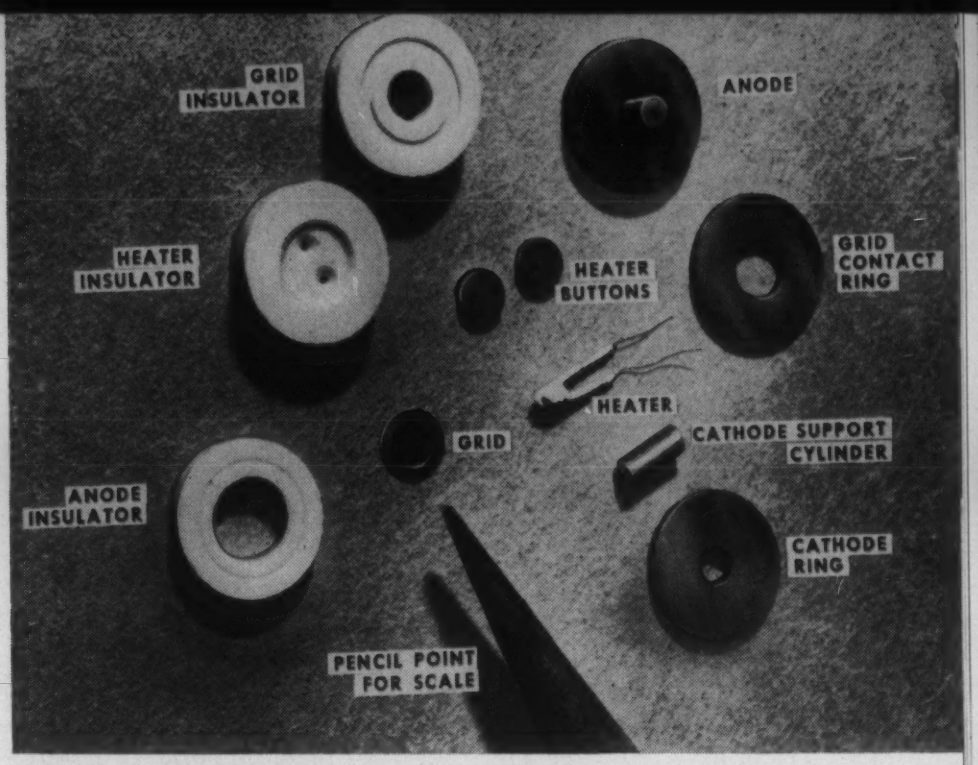
Du Pont had another problem at its Chambers Works. Stainless tubes handling 60% nitric acid at 480 F at 300 psi became so badly corroded that operations had to be suspended every four to six months. Du Pont engineers observed that the failure always occurred at the top of the condenser and that this area was the most vulnerable to corrosion. A titanium "top hat" was put to work. It consisted of a cluster of 70 thin walled titanium (A-55) tubes welded to a flat disc. Fitting snugly into the condenser, it protected the top 3 in. where failure had occurred.

The accompanying photograph shows the condenser after eight months' continuous service and six months' intermittent service. When the titanium insert was removed for inspection there were no visible signs of corrosion be-

(Continued on p 114)



***Titanium insert** protects condenser handling 60% nitric acid at 480 F and 300 psi. Area was formerly subject to heavy corrosion. "Top hat" has saved replacements and down-time.*



***Titanium and ceramic parts** for General Electric's microminiature electronic tube, 6BY4. Heater buttons, cathode, plate, and grid connections are made of titanium, as its thermal expansion matches that of ceramic.*

by G. T. Fraser, W. L. Finlay, A. G. Caterson, *Rem-Cru Titanium, Inc.*

. . . and Saving Money

Many applications of titanium are economically sound even at today's prices. The accompanying table shows a cost analysis of titanium and stainless finished assemblies. Although the price per pound of titanium sheet is 18 times more expensive than type 316 stainless, and the price per square foot is about ten times more expensive, the cost of finished equipment is roughly estimated to be only two or three times more expensive. But in many cases where titanium will outlast other materials by a factor of only two to three times, it should be the choice merely on the basis of replacements. Downtime for these replacements is another important consideration.

Omega, Inc., a pioneer in the manufacture of titanium anodizing racks, quotes a price of three times as much for titanium rack as against the same rack in aluminum. The Pfaudler Co., a large manufacturer of equipment for chemical process industry, quotes the following price on a 10-gal reactor: in stainless steel, $800; in a high chromium-nickel-molybdenum alloy, $1500; in titanium, $2800. A large titanium heat exchanger was recently quoted at $7637; the same heat exchanger in stainless steel was quoted at $3000. The titanium equipment was purchased.

COST ANALYSIS OF STAINLESS VS TITANIUM

	AISI Type 316 Stainless Steel	Rem-Cru A 70 Titanium	Cost Factor
Price per lb of 0.0625 sheet (1000-lb quantity)	$0.8325	$15.10	18
Price per sheet	Density 0.286 lb/in.^{3} 62.8 lb/sheet	Density 0.163 35.4 lb/sheet	10
Finished assembly cost (Assuming material costs are 20% of finished assembly in stainless)	Materials = x Fabricating = 4x Finished Assembly = 5x	Materials = 10.1x Fabricating = 4x Finished Assembly = 14.1x	less than 3

Where the choice is doubtful, two factors in the future will tend to tip the scales in favor of titanium. 1) Since 1951, the first year in which titanium was really produced as an engineering metal, there have been five price reductions. This downward trend is expected to continue. 2) Optimum methods of welding, forming and machining are just becoming well established. As wider experience is gained, manufacturing costs will be reduced which certainly will make finished titanium assemblies lower in cost.

Stainless steel and titanium *after exposure to calcium hypochlorite. Part at left is of AISI type 316 stainless; part at right is Rem-Cru A 70. After 7-mo operation, machining marks on the titanium are still visible.*

yond a slight discoloration.

At Wyandotte Chemicals Corp., a titanium impeller is used in a mixture of organic chlorides and a 3.5% solution of hydrochloric acid. A high nickel-chromium-molybdenum alloy, designed for resistance to hydrochloric acid was tried. It failed rapidly by pitting corrosion when free chlorine additions were made to the solutions. Titanium proved corrosion resistant to both the acid solution and the moist chlorine. After a year this impeller shows no visible sign of corrosion.

Another example of titanium equipment is a large impeller at Calera Mining Co. It was designed by Chemical Construction for Calera's cobalt recovery operation. The impeller operates in an autoclave with a 10 to 25% sulfuric acid solution at 600 psi and 400 F. The impeller is shown at the left of the accompanying photograph. The titanium letdown valve of the autoclave standing beside it handles the same solution.

A filter press at Pennsylvania Salt Manufacturing Co. presses solid cakes from a corrosive slurry of calcium hypochlorite. Stainless steel components were severely pitted within one to three weeks. After seven months, the machining marks on the titanium parts are still visible. Titanium is also proving valuable in making commercial bleach (sodium and calcium hypochlorite). Struthers Wells Co. recently completed a large titanium heat exchanger for making sodium hypochlorite. In it are several hundred feet of titanium.

Titanium equipment in the paper pulp industry is handling chlorine dioxide. Although chlorine dioxide gives superior whiteness and less fiber degradation, it is difficult to find suitable construction material. Stainless steels, including type 316, are rapidly pitted, particularly in an abrasive slurry. Special purpose alloy equipment shows more resistance, but service life is often disappointing.

During 1953 and 1954, titanium was tested for use in chlorine dioxide and showed virtually no corrosion. First, small titanium parts such as baffles, valves and nozzles were put to work. One nozzle when made of a high chromium-nickel-molybdenum alloy had to be replaced every 5 hr. Titanium nozzles are still in service after 13 months.

First large-scale use in the paper industry was a chlorine dioxide mixer, built by Improved Paper Machinery Co. for the Carolina Division of the Riegel Paper Corp. The mixer is lined with ⅛-in. thick A-70 sheet. The fact that titanium welds have equal corrosion resistance to the base metal was an important consideration in the design of the unit. Because the mixer was put into service at the end of 1955, it is too early to report any performance data. Service experience with this titanium lined unit should indicate whether or not titanium will be a practical material for large-scale installations in the paper industry.

Finishing and electronic uses

Titanium is finding wide use for anodizing racks. Titanium not only resists corrosion, but titanium fingers do not become nonconducting during the anodizing process. This saves the extra operation of stripping the rack between cycles. On the basis of production experience with anodizing racks, other racks operating in similar acid solutions, such as electropolishing and electroplating racks, are under test.

The corrosion resistance of titanium is not the only reason for its application. The General Electric microminiature electronic tube, 6BY4, is constructed of titanium and ceramic. Titanium is used for heater buttons, cathode, plate and grid connections. It was chosen partially because its coefficient of thermal expansion is well matched to the ceramic.

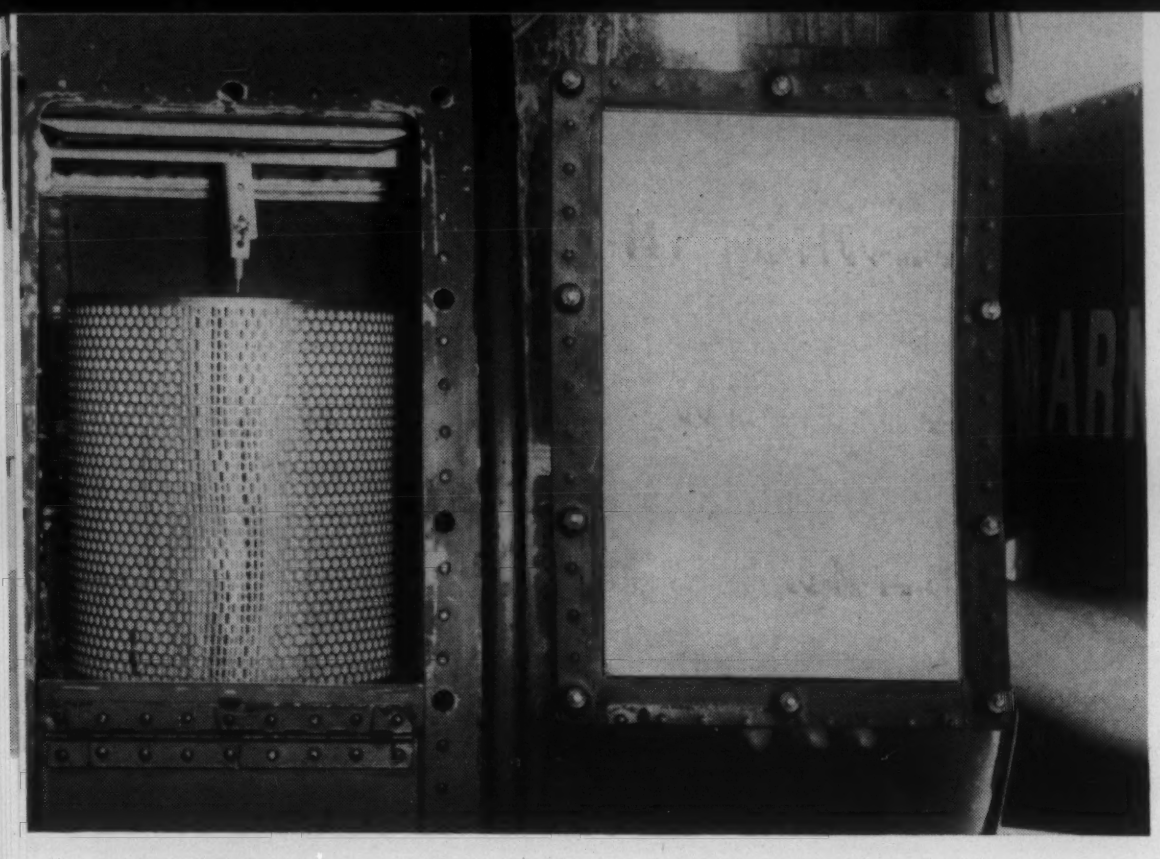
However, there are other important considerations. The titanium parts can be degassed at temperatures below those at which the oxide coated cathode becomes active. Once degassed, the titanium rapidly unites with oxygen and nitrogen, dissolves these gasses and holds them in permanent stable combination. Titanium parts protect the cathode by acting as a sump for the oxygen and nitrogen remaining in the tube after sealing.

Other applications where titanium appears to be a logical choice are still in the preliminary stage. In this category is the use of titanium for rocker arms in truck engines; for high speed centrifuges; for equipment to process the high temperature-high pressure distillation of sea water; for marine boiler feed pumps; for lightweight, corrosion resistant equipment in the food industry.

Plastics tools help launch turbo-prop

About 10,000 of the nearly 50,000 parts estimated to make up the Lockheed C-130 turbo-prop transport are produced with plastics tools, dies, jigs and fixtures. Plastics tools chop production time and cost, and permit amortization of tooling costs over the relatively short production runs common to the aircraft industry.

Possibly the largest plastics tool ever made is the master gage for checking alignment of the C-130's whole upper front window area. Shell of the gage is an epoxy-glass laminate made with Bakelite's epoxy resins, formulated by Rezolin, Inc. The frame of the gage is normalized steel, and is 18 ft wide by 14 ft deep by 9 ft high.



A new blind fastener quickly locks a panel in place, also acts as an elastic shock absorber. Its development hinged on the solution of a tricky materials problem.

Cover plate *in nose of Army helicopter is attached with Vibrex fasteners for ease of assembly and disassembly.*

An Unusual Fastener—

and the materials engineering that made it possible

by John B. Campbell, *Managing Editor, Materials & Methods*

How it works

The Vibrex fastener is a deceptively simple assembly. Made by Vibrex Fastener Corp., Mount Kisco, N.Y., it consists essentially of a steel stud with a slotted or wing head, a compressible rubber sleeve, a nylon cam and a notched steel pin. Fully assembled it can be inserted in a plain ½-in. hole and locked in place with less than half a turn of the stud.

Locking action is provided by the compressible sleeve. When the stud is turned clockwise the retaining pin, which rides on the cam surface, forces the cam back against the sleeve, compressing it and causing it to bulge outward. The retaining pin locks audibly by dropping into a notch in the cam surface. The bulge of the sleeve, together with the resulting spring force against the panel, provides a tight joint that also seals out dust and moisture. The fastener can be quickly unlocked by turning the stud counterclockwise. Locking and unlocking torque is about 4 in.-lb.

Where panels of more than a certain thickness are to be joined, a longer stud, together with a spacer washer (90 durometer rubber) considerably harder than the sleeve, is used. Since the spacer washer compensates for the additional panel thickness and does not compress, the locking bulge and the relative position of the sleeve remain unchanged. Where vibration or shock control is desirable, cushion washers are used between panels or between stud head and panel to eliminate metal-to-metal contact.

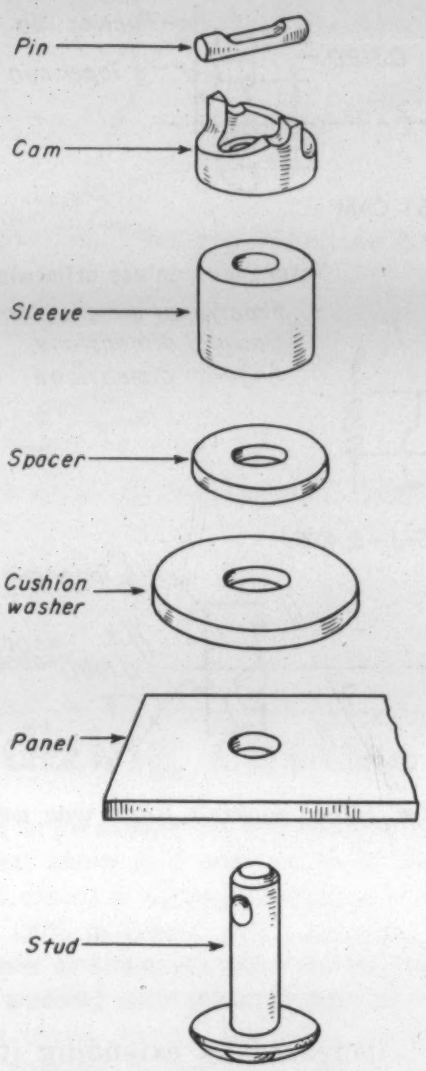
Where it's used

The Vibrex fastener is designed essentially to fasten two or more plates together. The most important uses of the fastener include: panel fasteners on various electronic chassis; anti-vibration mountings for instruments, motors, relays, fans, etc.; rattle-free joints in home appliances, especially air conditioners; and cabinet and drawer latches.

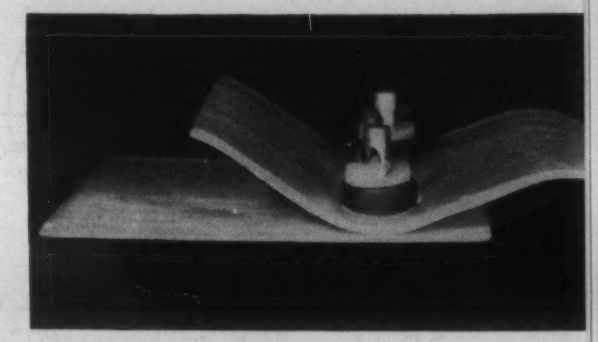
The fastener is unusually suitable for assembling soft or brittle materials—such as glass, ceramics, plastics and composition

board—since locking pressure has a maximum predetermined limit that cannot be exceeded by assembly personnel. One of the potentially most important applications of this kind where a blind fastener is essential is in the fastening of attachment plates or components to aluminum or glass-reinforced plastic honeycomb panels. Other important advantages of the fastener are 1) its ability to tolerate considerable misalignment, and 2) the ability of the sleeve to conform to a curved configuration—a feature that makes the fastener particularly suitable for use with components such as hollow tubes and corrugated sheet.

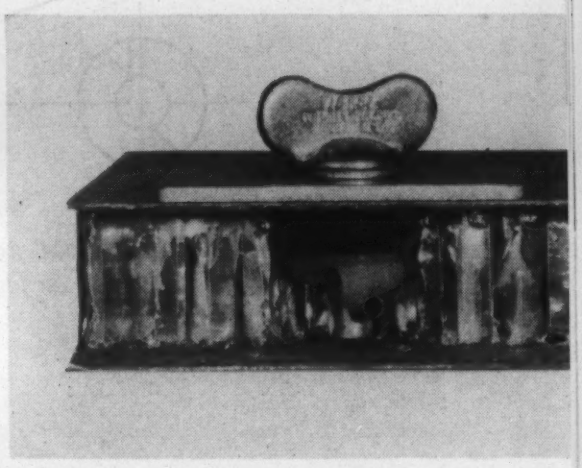
Use of the Vibrex fastener is limited to some extent by its relatively low pull-out strength (see later discussion on performance) and by the environmental properties of the rubber sleeve. The fastener is not suitable for use at high or extremely low temperatures, or in contact with oils.



Exploded view *of the Vibrex fastener. Spacer and cushion washers are used where needed.*



Corrugated sheets *show ability of the sleeve to conform to curved surfaces. Fastener is well suited to joining soft or brittle materials.*



Sandwich panels *are a promising application. Cut-away view shows how bulge of fastener sleeve pushes honeycomb aside.*

Its development

The successful development of the Vibrex fastener required the solution of knotty materials problems for two components—the sleeve and the cam.

The sleeve

Since the entire fastener is free to rotate, locking is dependent on a controlled balance of friction forces. The necessary load is supplied by the precompressed sleeve (0.350 in. long, 0.450 in. dia before precompression; 0.305 in. long, 0.484 in. dia after precompression). For the pin to ride up on the cam, the cam must rotate more slowly than the stud; hence, the friction force between cam and sleeve (and between sleeve and panel) must be more than the friction force between cam and pin.

The rubber compound used for the sleeve had to be specially developed to combine the frictional characteristics needed for a satisfactory locking bulge with the other necessary properties, such as long-time high compression set, limited permanent set and good fatigue life. Since no rubber manufacturer appeared to have any information on the friction coefficients of rubber, each change in the rubber compound required a change in the design of the cam, until finally a workable combination was achieved empirically. The material now being used—a natural rubber compound of 50 durometer hardness—was developed by Silentbloc, Ltd., in England, and is produced in this country by The General Tire & Rubber Co.

The cam

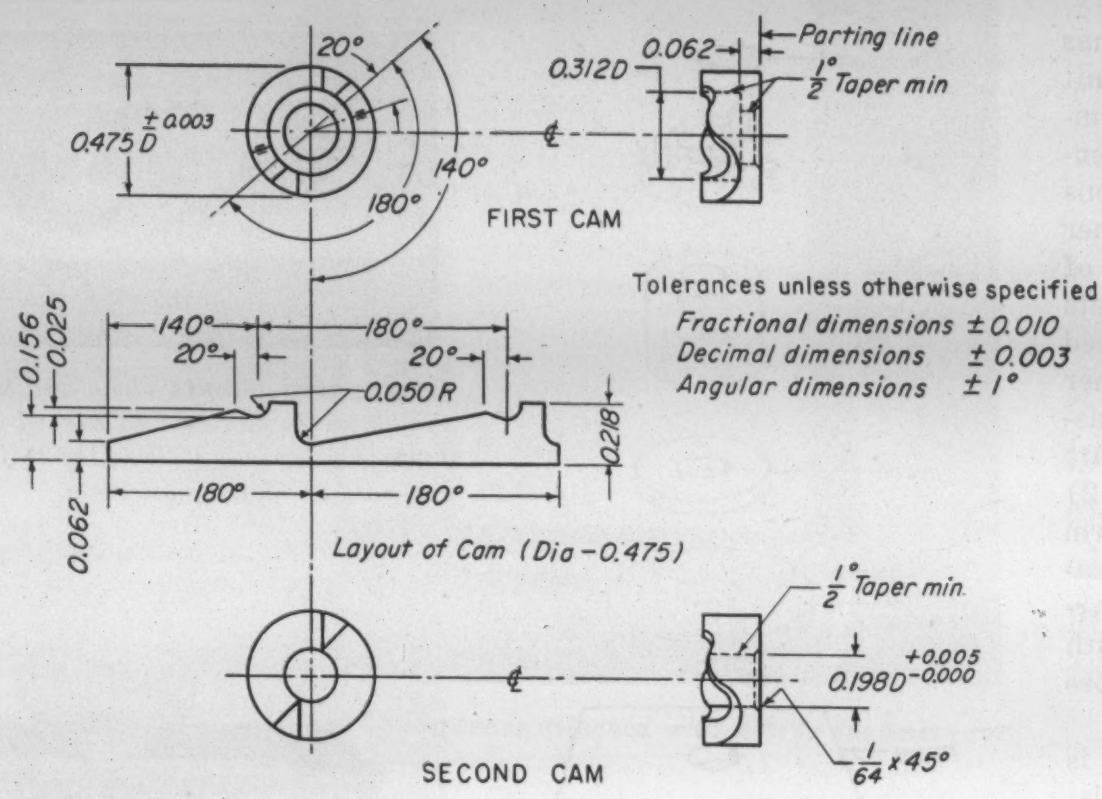
The cam originally used in England was machined from brass stock on a special purpose machine. This type of cam is still used in England, but proved far too expensive to make in this country. At 2.9¢ each, including customs duty, it was also too expensive to import.

The search for a less expensive cam with suitable frictional characteristics eventually involved sand castings, die castings and both molded and machined plastics:

1. Sand cast cams were unsuitable. The rough surface of the sand castings caused excessive friction between cam and pin. Even after tumbling, 89 cams out of 100 had to be rejected.

2. Nylon, both molded and machined from bar stock, appeared promising. However, the locking force of 150 lb proved to be too much for the nylon cam. Cold flow of the plastic caused fasteners with nylon cams to become completely unusable after a few days.

3. Die castings also looked promising initially. Several alloys and many different surface treatments, including tumbling with



Nylon cam redesign *Cold flow under 150-lb locking force was avoided by enlarging bearing surface as shown.*

lubricants for 6 hr, were tried. Whereas the operating torque of the fastener with the brass cam was about 4 in.-lb, the operating torque of the die-cast cam was more than 10 in.-lb. Friction between pin and cam was so high that the friction forces at the two ends of the sleeve were unbalanced; as a result, the sleeve tended to wind up torsionally when the fastener was tightened, thereby reducing sleeve life and establishing a tendency for the pin to jump out of its locking notch on the cam. All work with die castings was hampered by the fact that neither the die caster nor the Die Casting Institue had any information on the friction coefficients of die-cast alloys with either steel or rubber.

4. Powder metallurgy was not seriously considered, since the lowest bid was 2.7¢, plus high die costs.

The ultimate solution to the problem was nylon, plus a redesign of the cam. The material selected was Du Pont's Zytel 101 molding compound and, on the supplier's recommendation, the bearing surface of the cam was increased by extending it to the inside diameter of the cam proper. Although no cold flow occurred, the friction force between pin and cam was increased to the extent that the fastener required an operating torque of 8 in.-lb. The friction coefficient of the plastic was then reduced by incorporating a lubricant in the molding compound, and the operating torque of the fastener was correspondingly reduced to about 4 in.-lb—equal to that of the original fastener with the brass cam. No cold flow was discernible even when the fastener was kept locked for 12 months. Cost per cam was only 0.6¢—lowest of all cams tested.

End result of the cam development, therefore, was a part that cost only a fifth as much as the original and, in addition, was lighter in weight—a significant advantage in aircraft applications. The manufacturer reports one drawback, however: prejudice against the nylon cam on the part of some customers who have had experience with cold flow in nylon. For such customers, the manufacturer supplies a more expensive cam machined from Duralumin.

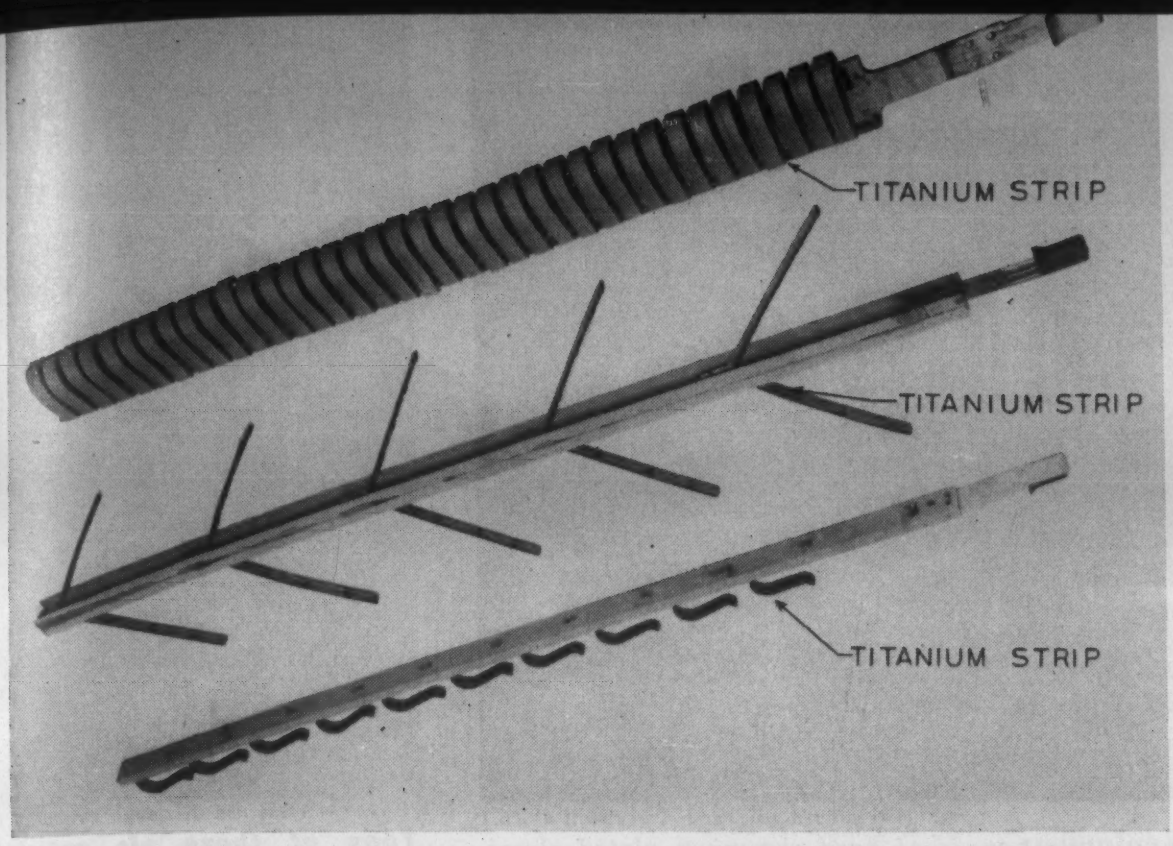
Its Performance

Permanent set—The satisfactory functioning of the Vibrex fastener depends on the ability of the rubber sleeve to recover, within certain limits, its original dimensions when it is released after having been compressed for an extended period of time. In assemblies subjected to accelerated aging at 158 F for seven days, permanent set of the sleeve in no case exceeded 30% up to a compression of 50%, and the fasteners operated satisfactorily in all cases.

Static loading—The direct pull load on the fastener required to produce initial separation of two panels varies with the thickness of the materials. For a 3/16-in. panel, a 1/16-in. base and a 0.508-in. hole, it was 12 lb, and the load required to produce a visual permanent set was 60-65 lb. These loads were higher for thicker bases and for thicker panels, and vice versa. In all cases, the load required to pull the panels apart exceeded a single load application of 110 lb.

Vibration—The behavior of the locked, loaded fastener when subjected to continuous external vibration was measured by providing four assembled fasteners in a panel with a total static load of 43 lb, an out-of-balance load of 3½ oz, a radius of load of 1¼ in., a vibration frequency of 2000 cpm, and an acceleration due to vibration of 0.5 g. After a 72-hr period the fastener showed no deterioration. The panel had settled 0.015 in.—about 10% of the annular thickness of the rubber sleeve.

Other—The Vibrex fastener is claimed to withstand: 5000 locking-unlocking cycles; service temperatures from —65 to 165 F; 250 hr of salt spray; and 2500 v. Assembled with an external cushion washer, it does not leak when exposed to 1) 30 psi air pressure from either side, 2) three days' immersion in water at 4-ft depth, 3) 12 hr hose spray, 4) 5 hr sand blast, and 5) 24 hr of tumbling at 100 rpm in either dry dust or wet mud.



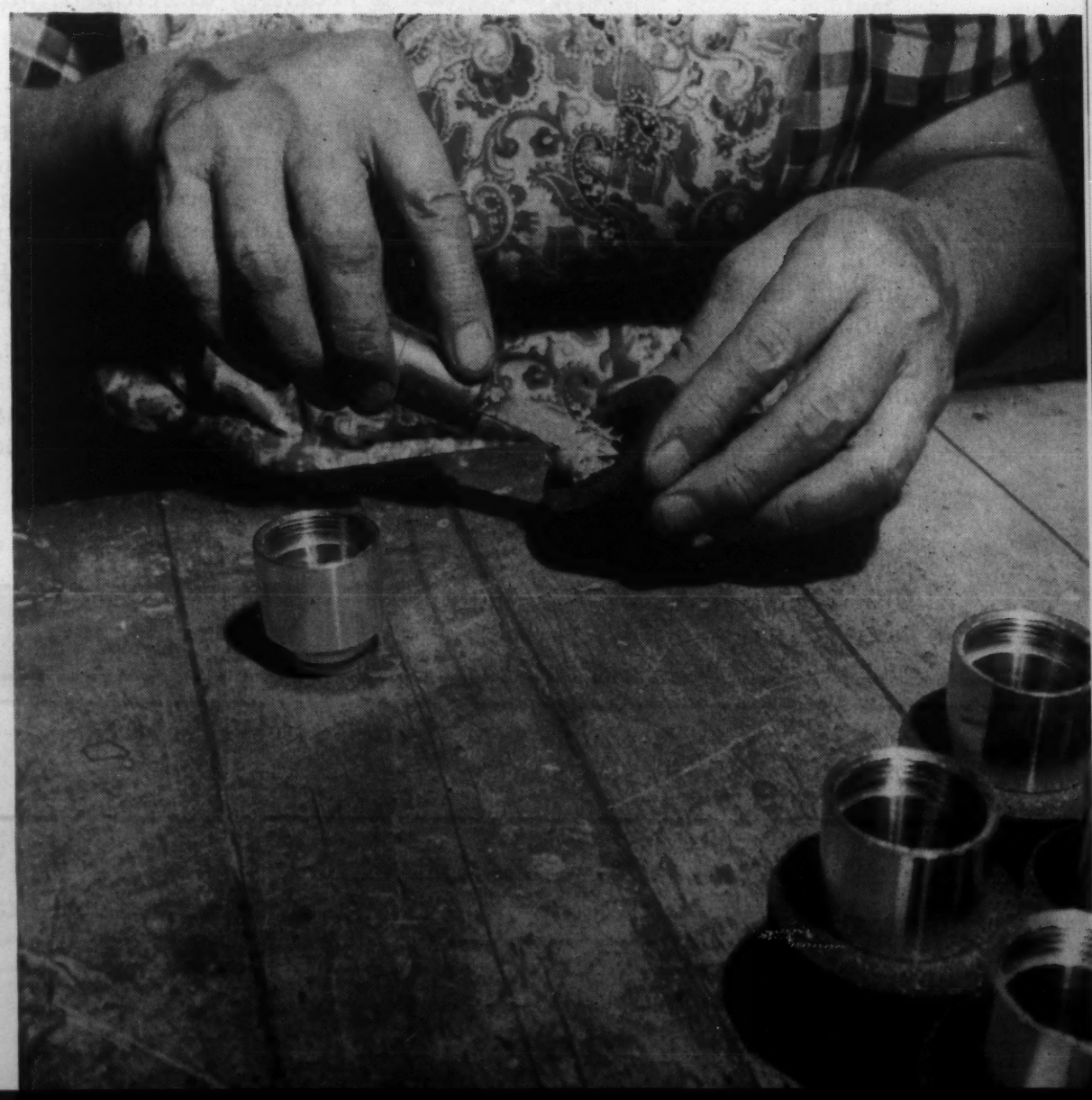
Titanium reduces anodizing costs

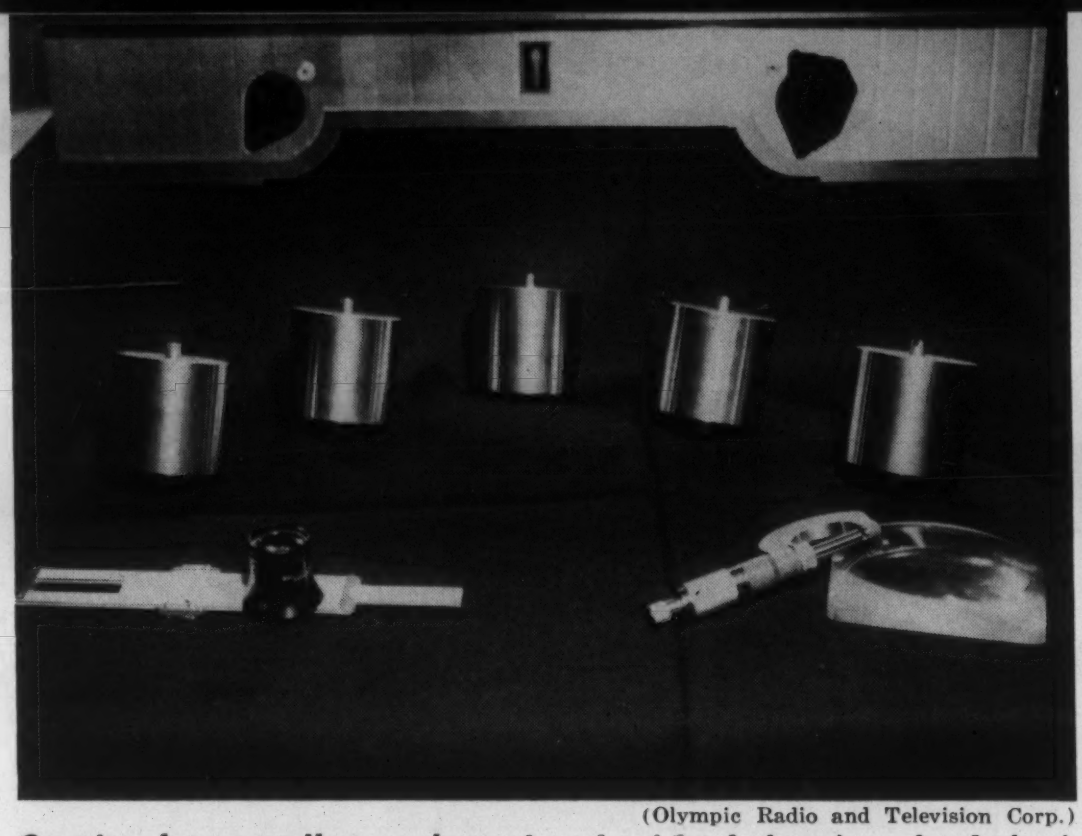
Specially treated titanium contact points on anodizing racks are reducing costs and improving the operating efficiency of chromic acid anodizing of aluminum parts at Douglas Aircraft Co. Use of the titanium strips eliminates stripping, necessary with conventional work holders, and permits the d.c. electrical source to deliver full power to the work since the rack draws negligible current.

To obtain the second advantage, a special treatment for the titanium was developed that limits peak current density to 2 amps per sq ft. The treatment consists of cleaning the titanium in hot nitric acid (50% by volume), rinsing and drying. This is followed by heating to 1300 F for one hour. Using the anodizing racks repeatedly does not lower the peak current density. The treated contact points are estimated to save 1.5 kw per sq ft in each anodizing cycle.

Epoxy adhesive cuts grinding wheel rejects

Use of an epoxy-based adhesive has reduced wheel dressing and rejections of valve seat grinding wheels produced by The Sterling Grinding Wheel Co. In producing this type of wheel, the vitrified wheel must be securely bonded to an aluminum insert, exactly on center and without the slightest warpage. With the resinoid cement formulation previously used, the thin aluminum insert tended to warp, resulting in excessive dressing and, in some cases, rejections. The epoxy adhesive has higher bond strength and low shrinkage. It is produced by Armstrong Products Co., and is based on Shell's Epon epoxy resin.





(Olympic Radio and Television Corp.)

Capstan for recording equipment *made of hard chromium plated aluminum to solve a weight and wear problem. This part was formerly made from stainless steel and the operation involved drilling five holes and balancing to reduce weight.*

(Eastern Aircraft Products Corp.

Tops of these air regulators *which lead from engine compressor to cabin, are made of hard chromium plated aluminum to obtain high abrasion resistance.*

New Chromium Plate for Aluminum and Titanium

Products like those shown use a recently developed, hard, ductile, heat resistant coating to advantage.

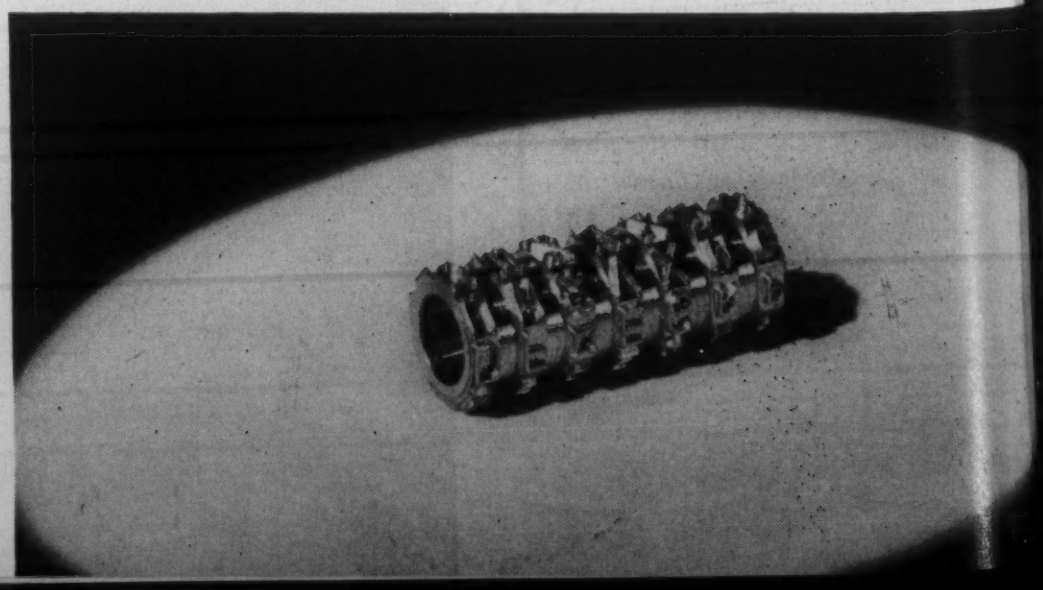
by Paul J. Topelian,
Vice President, Tiarco Corp.

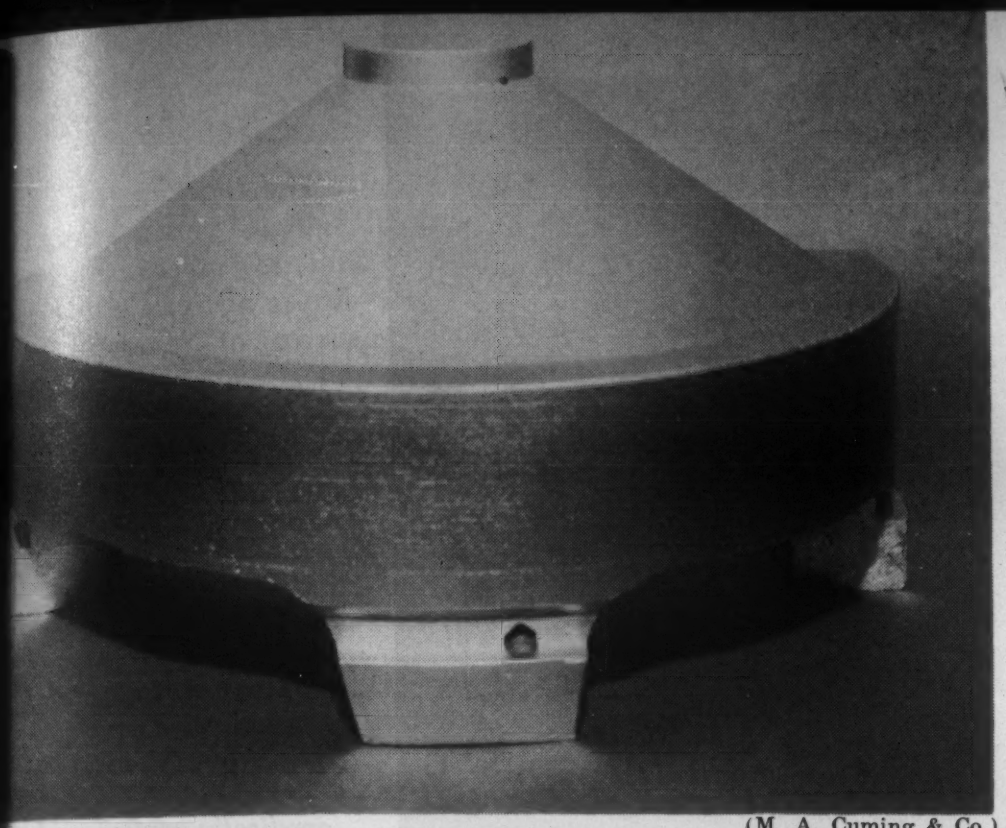
■ Hard, ductile chromium plate is deposited on aluminum and titanium by a process developed recently. In this procedure deposits from 0.002 to 0.030 in. thick are made directly on the base metal after suitable surface preparation. This contrasts with conventional plating methods for aluminum which require successive deposits of zinc, copper, and nickel before the chromium can be applied.

Chromium plated aluminum parts are in use in competition with certain types of steel for wear resistant applications while the chromium plating of titanium parts has overcome galling and seizing characteristics that have prevented the use of titantium for certain applications.

Special surface preparation is necessary to permit plating directly on active metals like aluminum and titanium. For aluminum, a three-stage process (Hardalume) is used. The first prevents oxidation of the cleaned surface by passivating the metal, the second reactivates the surface during deposition of a bonding coat of chromium and the third deposits hard chromium to the required thickness. For titantium, immersion in a special surface activating bath (the Baylig process) follows surface cleaning. The plating solu-

Imprint roll *used by a large tabulating machine maker. Originally this roll was engraved in nonmagnetic stainless steel. Now an engraved 2024 aluminum roll is chromium plated by the new process. The steel roll was discarded because of loss of clarity after 8,000,000 impressions, while the chromium-plated aluminum roll has made over 18,000,000 impressions.*





(M. A. Cuming & Co.)

Molds *for reinforced plastics are chromium plated to obtain improved mold surface and part release and to prevent the transfer of oxide contamination from the mold to the finished part.*

tion is modified to meet titanium's unique requirements, otherwise it is similar to the usual hard chromium plating solutions.

Properties of the coating

The hardness of the chromium deposit averages Rockwell C72 but runs as high as C80. The deposit is 15% denser than conventional hard chromium coatings and is quite ductile. Hammering causes flow of the deposit but no cracking. The deposit adheres so tightly to the base metal that samples on which chromium has been deposited can be twisted or bent without separating the coating. Heating of chromium-plated aluminum tubing to 1300 F results in melting the internal aluminum surface (uncoated) while the tube retains its form and the chromium coating is not distorted although it is discolored. This would appear to indicate that alloying has occurred between base metal and coating or, as has been suggested, the bond is atomic.

One of the advantages of the chromium plate is development of a highly abrasion resistant surface on a light metal. For example, the abrasion resistance of this plating is more than a hundred times that of bare aluminum and ten times that of hard nickel plate.

Another advantage of the coating, specifically on titanium, is the reduction in friction. An accompanying table gives the coefficients of friction for a number of metal-to-metal combinations. The frictional coefficient of titanium on Babbitt is about three times as high as steel on Babbitt, while chromium plated titanium has the same coefficient of friction against a similar surface as chromium plated steel.

Applications

The combination of abrasion resistance with light weight has led to a number of applications for hard chromium plated aluminum. One of the large tabulating machine producers has been using imprint rolls made by engraving stainless steel. The rolls lasted for about 8,000,000 impressions before losing clarity and being discarded. Replacement rolls are now produced from 2024 aluminum hard chromium plated by the new process. These rolls are still in service after 18,000,000 impressions.

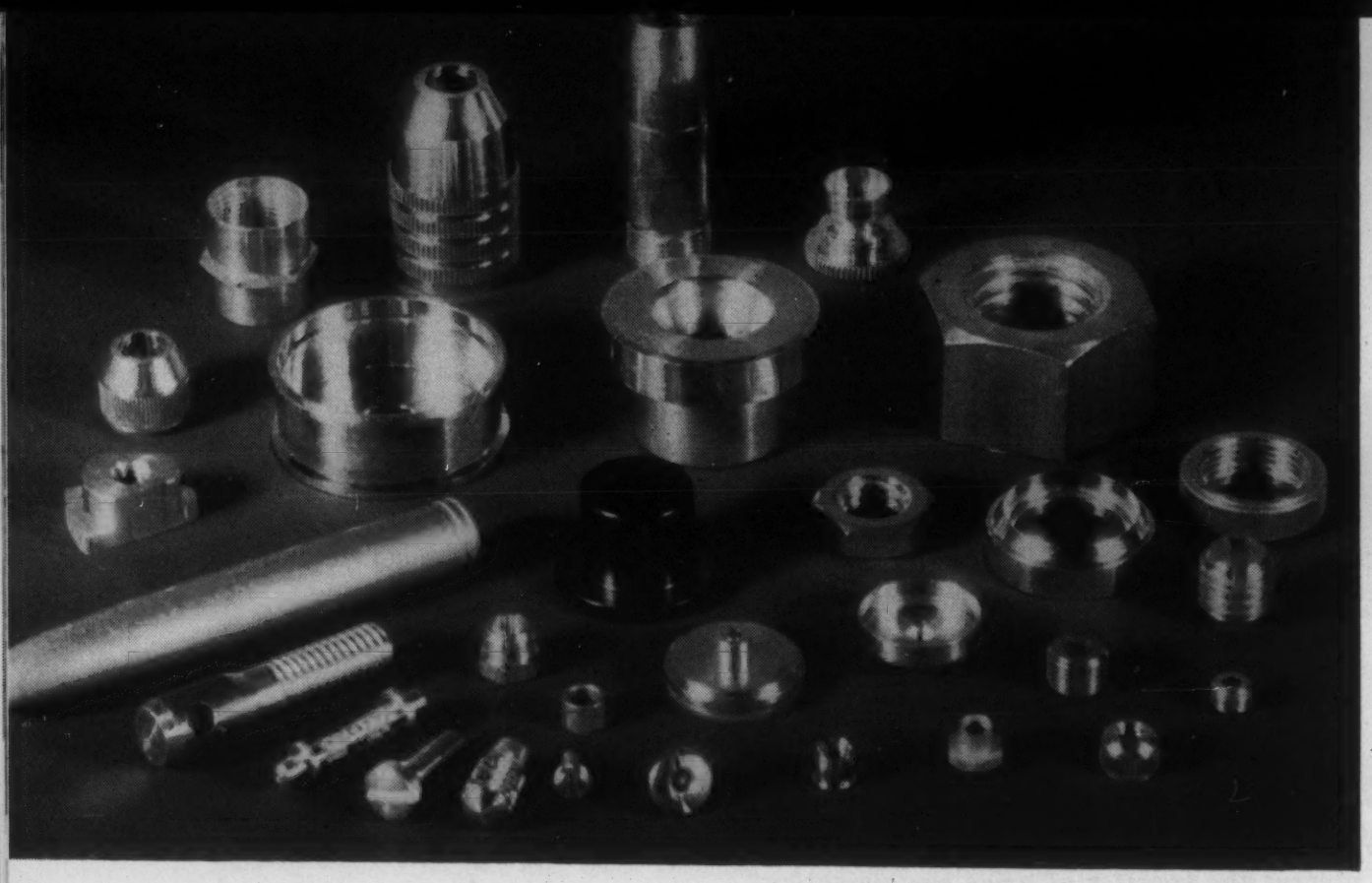
Several food processing companies have been using plastic-coated brass heat exchangers to heat-seal cellophane packages. In one plant, these heat exchangers were replaced after 8 weeks' service. Standard hard chromium plated aluminum parts lasted 10 weeks while parts plated by the new process were in service for 14 months.

The coating process has excellent throwing powers and deposits can be made on irregular contours. A successful application of chromium plated aluminum has been made in the production of molds for reinforced plastics. The chromium surface has an improved surface and no parting agent is required to obtain mold release. A further advantage is the ability to machine aluminum molds at a fraction of the cost of steel molds, and it is expected that the chromium surface will increase the life of aluminum molds sufficiently to enable them to compete with steel molds. Thus far molds have been used for the production of aircraft parts, fire helmets and gutters.

Seizing and galling of titanium have been so severe that applications involving sliding contact have not been successful. Hard chromium plating has overcome this problem satisfactorily. Pistons produced from titanium alloy 150A chromium plated by the Baylig process have been employed in an experimental weapon. These pistons resisted the combined effects of corrosion and erosion better than untreated parts. Hard chromium plated commercial titanium gears have been found satisfactory also.

FRICTIONAL EFFECTS

Combination	Coefficients	
	Static Friction	Sliding Friction
Titanium on Babbitt	0.67 (approx)	0.60 (approx)
Steel on Babbitt	0.25	0.20
Steel on Chromium Plated Steel	0.17	0.16
Chromium Plated Steel on Babbitt	0.15	0.13
Chromium Plated Steel on Chromium Plated Steel	0.14	0.12
Chromium Plated Titanium on Chromium Plated Titanium	0.14	0.12



Typical parts *made of aluminum stock on automatic screw machines. Part in center has dyed anodically applied oxide finish.*

These components are produced as

Aluminum Alloy Screw Machine Parts

because of these advantages:

- *Excellent machining properties*
- *Light weight*
- *High scrap recovery*

by Floyd A. Lewis, *The Aluminum Assn.*

Alloys that can be used

Four aluminum alloys account for the bulk of production of aluminum screw machine parts. Mechanical and physical properties are given in accompanying tables, as well as dimensional tolerances for rolled bar, rod and wire and drawn tube. The typical mechanical properties listed in Table 1 are averages that take into account variations introduced by type of product, size, shape and method of manufacture. They are higher than the specified minimum properties shown in succeeding tables.

Although the alloys normally used in the manufacture of aluminum screw machine products all have excellent machining characteristics, they are not equal in this respect. In the tables the alloys are listed in order of relative machinability. The machinability ratings take into account such factors as power required to machine, ability to machine fine finishes and close tolerances, speeds and feeds, chip size and tool life. Alloy 2011 was developed especially for screw machine products and has the best all-around machining characteristics. After alloy 2011 come alloys 2017 and 2024, which have about the same machining characteristics.

All of these alloys are of the heat treatable type. Screw machine stock normally is supplied in heat treated condition, not only for the additional strength, but also because heat treated stock machines more readily than non-heat treated stock. Heat treated tempers normally specified for screw machine stock are given in the tables.

From an economic standpoint, it is desirable generally to choose the alloy with the best machining characteristics that will meet the other requirements. For this reason, alloy 2011 should be specified wherever possible. Its lead and bismuth content gives this alloy optimum machining speed with an excellent machine finish, and the chips are finely divided and easy to handle. It is normally used in the T3 temper, but T8 stock sometimes is specified for parts involving deep drilling operations.

Alloys 2017 and 2024 are used where their higher strength and hardness are required. Alloy 2017 often is selected for products involving deep drilling operations. Alloy 2024 is generally used for aircraft fittings. Because of its high shear strength, this alloy also is used for all types of threaded fasteners. Machining costs are higher for these alloys than for 2011, and tools ground with hooks or chip breakers sometimes are required.

Alloy 6061 has somewhat lower

mechanical properties than alloys 2011, 2017 and 2024, but it has superior corrosion resistant qualities which make it useful where high resistance to corrosion is required. Alloy 6061 is preferred for parts that are to be welded, brazed or soldered to other parts. It can be machined to an excellent finish, and it has superior characteristics where anodically applied oxide coatings are desired.

Design suggestions

To gain full advantage of the flexibility of aluminum alloys as a material for screw machine parts, the user should work closely with the supplier, even in the design stages. Where permissible, the user should tell the supplier the use of the part. The supplier, with his experience, can often suggest ways to reduce the cost of the part and can aid the user in selecting the best and most economical alloy for the job.

Many helpful suggestions to designers and users are given in a *Buyers Guide for Design of Screw Machine Products* recently issued by the National Screw Machine Products Assn. Most of these suggestions apply as well to aluminum alloys as to other materials commonly used for these products.

Standard sizes and shapes

Designs should be developed so as to use standard shapes and sizes of stock as far as possible. In aluminum alloys this includes round stock up to 8 in. in dia, square bar up to 4 x 4 in. and hexagonal bar up to 3 in. across flats. Standard 12-ft lengths are furnished for all sizes up to and including 2¾ in. Random lengths are supplied in larger sizes. Drawn round tube is regularly produced with outside diameters ranging from ⅛ up to more than 10 in. In most cases, the manufacture of screw machine parts from stock of the upper size ranges is uneconomical. In any case, the maximum size stock a manufacturer can handle will depend on the size of his largest machine.

Secondary operations

After the piece has been cut off, secondary operations add to the cost. For relatively short runs, however, the over-all cost of manufacturing a given part may be lowered by substituting one or more secondary operations for automatic operations where the

Table 1—TYPICAL MECHANICAL PROPERTIES

Alloy and Temper*	Tensile Strength, psi		Elong in 2 in., %	Brinnell Hard. 500 Kg Load 10 mm Ball	Shear Str, psi	Fatigue Endur Limit[a], psi	Mod of Elast[b], psi
	Ult	Yld					
2011-T3	55,000[c]	43,000[c]	15	95	32,000	18,000	10.2×10^6
2011-T8	59,000	45,000	12	100	35,000	18,000	10.2×10^6
2017-T4	62,000	40,000	22	105	38,000	18,000	10.5×10^6
2024-T4	68,000	47,000	19	120	41,000	20,000	10.6×10^6
6061-T6	45,000	40,000	17	95	30,000	14,000	10.0×10^6

** Listed in order of relative machinability. Tempers shown are for stock normally used for screw machine products.*

[a] Based on 500,000,000 cycles of completely reversed stress using the R. R. Moore type of machine and specimen.

[b] Average of tension and compression moduli. Compression modulus is about 2% greater than tension modulus.

[c] Sizes greater than 1½ in. will have strengths 15 to 20% lower than these values.

Table 2—MECHANICAL PROPERTY LIMITS OF ROLLED AND COLD-FINISHED WIRE ROD AND BAR*

Alloy and Temper**	Thick.[a], in.	Strength, psi (min)		Elong[b] in 2 in. or 4 D[c], % (Min)
		Ult	Yld[b]	
2011-T3	0.125-1.500	45,000	38,000	10
	1.501-2.000	43,000	34,000	12
	2.001-3.000	42,000	30,000	14
2011-T8	0.125-3.250	52,000	40,000	10
2017-T4	Up through 6.00	55,000	32,000	16
2024-T4[d]	Up through 6.50	62,000	40,000	14
6061-T6	Up through 6.00	42,000	35,000	10

** Wire (except flattened wire) has a diameter or width less than 0.375 in. Rod has a diameter of 0.375 in. or greater. Bar has a width of 0.375 in. or greater.*

*** Listed in order of relative machinability. Tempers shown are for stock normally used for screw machine products.*

[a] For material 1½ in. or less in thickness. When not tested in full-section, the tension test specimen is taken from the center of the section: for material over 1½ in. in thickness the specimen is taken midway between the center and surface. Specimens are taken parallel to the direction of rolling.

[b] The measurement of elongation and yield strength is not required for wire less than 0.125 in. in thickness.

[c] D represents specimen diameter

[d] 36 sq in. maximum area.

Table 3—MECHANICAL PROPERTY LIMITS OF DRAWN TUBE

Alloy and Temper	Wall Thick., in.	Strength, psi (min)		Elong in 2 in. or 4D[a] % (min)	
		Ult	Yld	Full Sect. Specimen[b]	Cut-out Specimen[c]
2024-T3	0.018-0.024	64,000	42,000	10	—
	0.025-0.049	64,000	42,000	12	10
	0.050-0.259	64,000	42,000	14	10
	0.260-0.500	64,000	42,000	16	12
6061-T6	0.025-0.049	42,000	35,000	10	8
	0.050-0.259	42,000	35,000	12	10
	0.260-0.500	42,000	35,000	14	12

Specimens tested parallel to the direction of drawing.

[a] D represents diameter of cut-out specimen.

[b] Round tube 2 in. or less in o.d. and square tube 1½ in. or less on a side are tested in full-section unless the limitations of the testing machine preclude the use of such a specimen.

[c] For round tube over 2 in. dia., for square tube over 1½ in. on a side, for all sizes of tube other than round or square, or in those cases when a full-section specimen cannot be used, a cut-out specimen is used.

latter would involve high tooling cost. For long production runs, tooling for complete automatic production usually will result in the lowest over-all cost. Where only a nominal quantity of a given part is ordered in the beginning but will be reordered later, the user should so inform the supplier so that he can choose the most economical tooling setup for the larger total production involved.

Tolerances

Parts made on automatic screw machines inherently have a fine finish and relatively close dimensional tolerances, but designers should specify no closer tolerances or finer finishes than are needed. The closer tolerances must be held, the more expensive tooling, gaging and inspection become. All machining operations obviously add to the over-all cost.

Hole diameters

Insofar as service requirements will permit, designers should specify hole diameters obtainable with standard drills and reamers. Tooling costs for holes of other sizes are obviously higher.

Thread specifications

Thread specifications are an important part of the design of any part involving thread cutting operations. Wherever possible, either American National or Unified threads should be specified. Such threads are readily cut with standard taps and dies. Other threads require special tooling which adds to the cost. Three classes of standard tolerances are available under the Unified screw thread system. Class 1 threads are for special uses where loose fit is required for finger assembly, as for some types of ordnance parts. Class 2 threads are normally specified for screws, bolts, nuts and tapped holes. Class 3 threads have closer tolerances than Class 2. On external threads, the design should allow the maximum distance possible between the end of the thread and the shoulder, and in tapped holes for the maximum possible distance between the end of the thread and the bottom of the hole. Tests show that a thread cut to a depth of 65% of the depth of the hole provides ample strength for most applications, provided this thread depth is not less than the diameter of the screw.

Table 4—DIAMETER TOLERANCES—ROUND WIRE AND ROD

Specified Diameter, in.	Allowable Deviation from Specified Dia, in. (plus and minus)			
	Drawn Wire	Cold Finished Rod	Rolled Rod	
			Plus	Minus
Under 0.036	0.0005	—	—	—
0.036-0.064	0.001	—	—	—
0.065-0.374	0.0015	—	—	—
0.375-0.500	—	0.0015	—	—
0.501-1.000	—	0.002	—	—
1.001-1.500	—	0.0025	—	—
1.501-2.000	—	0.004	0.006	0.006
2.001-3.000	—	0.004	0.008	0.008
3.001-3.499	—	—	0.008	0.008
3.500-5.000	—	—	0.031	0.016
5.001-8.000	—	—	0.062	0.031

Table 5—DIAMETER TOLERANCES—CENTERLESS GROUND ROUND WIRE AND ROD

Specified Diameter, in.	Allowable Deviation, in. (plus and minus)
0.125-0.374	0.0005
0.375-0.625	0.0005
0.626-1.500	0.0010
1.501-2.000	0.0025

Table 6—TOLERANCES FOR DISTANCE ACROSS FLATS—SQUARE AND HEXAGONAL WIRE AND BAR

Specified Distance across flats, in.	Allowable Deviation, in. (plus and minus)		
	Drawn Wire	Cold Finished Bar	Rolled Bar
Under 0.036	0.001	—	—
0.036-0.064	0.0015	—	—
0.065-0.374	0.002	—	—
0.375-0.500	—	0.002	—
0.501-1.000	—	0.0025	—
1.001-1.500	—	0.003	—
1.501-2.000	—	0.005	0.016
2.001-4.000	—	—	0.020

Burr removal

If the application for which the part is intended does not require removal of the burrs resulting from machined edges, deburring should not be specified. Chamfered corners are cheaper and simpler to produce than rounded corners and usually are just as satisfactory.

Chip removal

Because of the light weight of aluminum alloys, removal of chips during manufacture requires somewhat more attention than for heavier metals. While this is primarily a matter for the manufacturer to cope with, the designer sometimes can incorporate minor changes that will facilitate chip removal and aid in keeping the cost down. For example, a straight-sided annular groove sometimes will harbor chips and require a hand opera-

tion to remove them. A slight taper on the outer surface of the groove permits chip removal during manufacture and eliminates the necessity for hand removal.

Finishes

Because a machine finish by itself is attractive, many screw machine parts need no additional finishing. Where desired, however, aluminum screw machine parts may be given further treatment to produce bright, dull or satiny surfaces. In addition to the purely mechanical finishes, such as those used with other metals, chemical and anodically applied oxide finishes are available for aluminum to provide added protection against corrosion or abrasion. Both of the latter types of finishes are available in a variety of colors either for identification or to provide desired decorative effects.

A burnishing finish in a tumbling barrel is the most usual mechanical finish applied to aluminum screw machine products. Burnishing smoothes out projecting points or particles, flattening and spreading them out. While it is not as bright as a buffed finish, a burnished surface is harder and less susceptible to marring.

Hand finishing is more costly than burnishing, but will provide a variety of surfaces. Such standard mechanical finishes as greasing, buffing, color-buffing, and scratch brushing are often used for aluminum parts. A satin finish is produced by dipping parts into a suitable chemical bath, then rinsing and drying. Some chemical finishes may include a dyeing operation.

While more expensive, anodically applied oxide finishes provide greater protection against abrasion than chemical finishes and increase resistance to corrosion. To provide for the extra thickness of these finishes, parts to be anodically coated are kept on the low side of tolerance limits for outside diameters and on the high side for inside diameters.

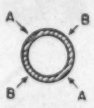
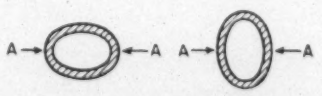
When specifying aluminum screw machine parts remember these points . . .

1. Drawings for screw machine parts should specify full details of the design so that supplier knows exactly what requirements he must meet. If a sample is available, this should be submitted with drawing, but in all such cases, drawing takes precedence over the sample.
2. Order as large a quantity of parts as possible. Machine setup time is same regardless of length of run. If setup cost can be distributed over a long production run, a corresponding production economy is realized.
3. Tell supplier what inspections you make of finished parts so that he can set up his inspection procedures accordingly. Inspection should be adequate, but avoid any unnecessary inspection.
4. Discuss with supplier packing of the finished parts so that all close fittings and exposed surfaces may be protected during shipment.

Table 7—WALL THICKNESS TOLERANCES—ROUND DRAWN ALUMINUM TUBE (HEAT TREATED ALLOYS) [1] [2]

Specified Thickness[4] in.	Allow. deviation of mean wall thick.[3] Diff. between ½ (AA+BB) and specified wall thick., in. (plus and minus)	Allow. deviation of wall thick. at any pt. Diff. between AA and specified wall thick., in.
0.010-0.035	0.002	
0.036-0.049	0.003	
0.050-0.083	0.004	
0.084-0.120	0.005	Plus and minus 10% of specified wall thickness, min ± 0.003
0.121-0.203	0.006	
0.204-0.300	0.008	
0.301-0.375	0.015	
0.376-0.500	0.020	

Table 8—DIAMETER TOLERANCES[2]—ROUND DRAWN ALUMINUM TUBE (HEAT TREATED ALLOYS)

Specified o.d. or i.d., in.[1]	 Allow. deviation of mean dia[5] Diff. between ½ (AA+BB) and specified dia, in. (plus and minus)	 Allow. deviation of dia at any pt.[6] Diff. between AA and specified dia, in. (plus and minus)
Under 0.501	0.003	0.006
0.501-1.000	0.004	0.008
1.001-2.000	0.005	0.010
2.001-3.000	0.006	0.012
3.001-5.000	0.008	0.016
5.001-6.000	0.010	0.020
6.001-8.000	0.015	0.030
8.001-10.000	0.020	0.040
10.001-12.000	0.025	0.050

[1] *When outside diameter, inside diameter and wall thickness are all specified, standard tolerances are applicable to any two of these dimensions, but not to all three.*

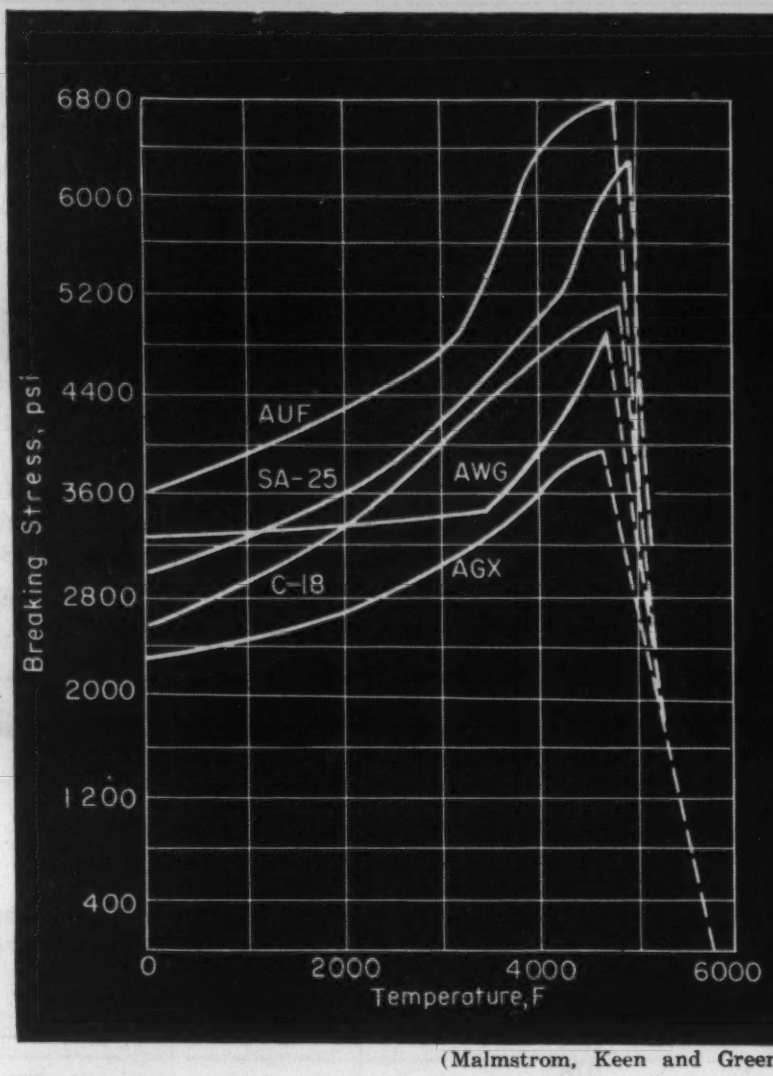
[2] *When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which would apply to the mean of the maximum and minimum dimensions permissible under the tolerance.*

[3] *The mean wall thickness is the average of two measurements taken opposite each other.*

[4] *When dimensions specified are outside and inside wall thickness itself, allowable deviation at any point (eccentricity) is ±10% of the mean wall thickness but not less than ±0.003 inch.*

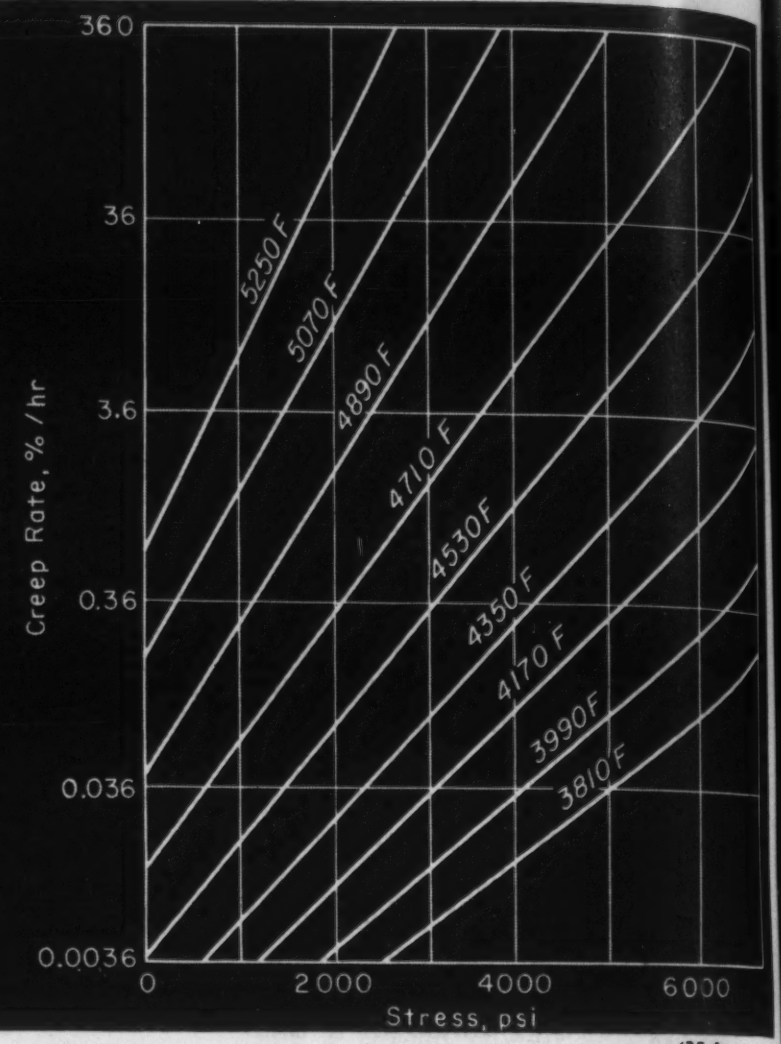
[5] *Mean diameter is the average of two diameter measurements taken at right angles to each other at any point along the length.*

[6] *Not applicable to tube having a wall thickness less than 0.020 in. or less than 2½% of the outside diameter.*



(Malmstrom, Keen and Green)

Fig 1 *High temperature tensile strength of five grades of graphite.*



(Malmstrom)

Fig 2 *Creep rates of extruded ECA grade parallel to direction of extrusion.*

The above charts show

How Graphite Performs

Because graphite is stronger at 4500 F than at room temperature, higher in thermal conductivity than other refractories, and low in thermal expansion, it is finding increasing applications in the high temperature field.

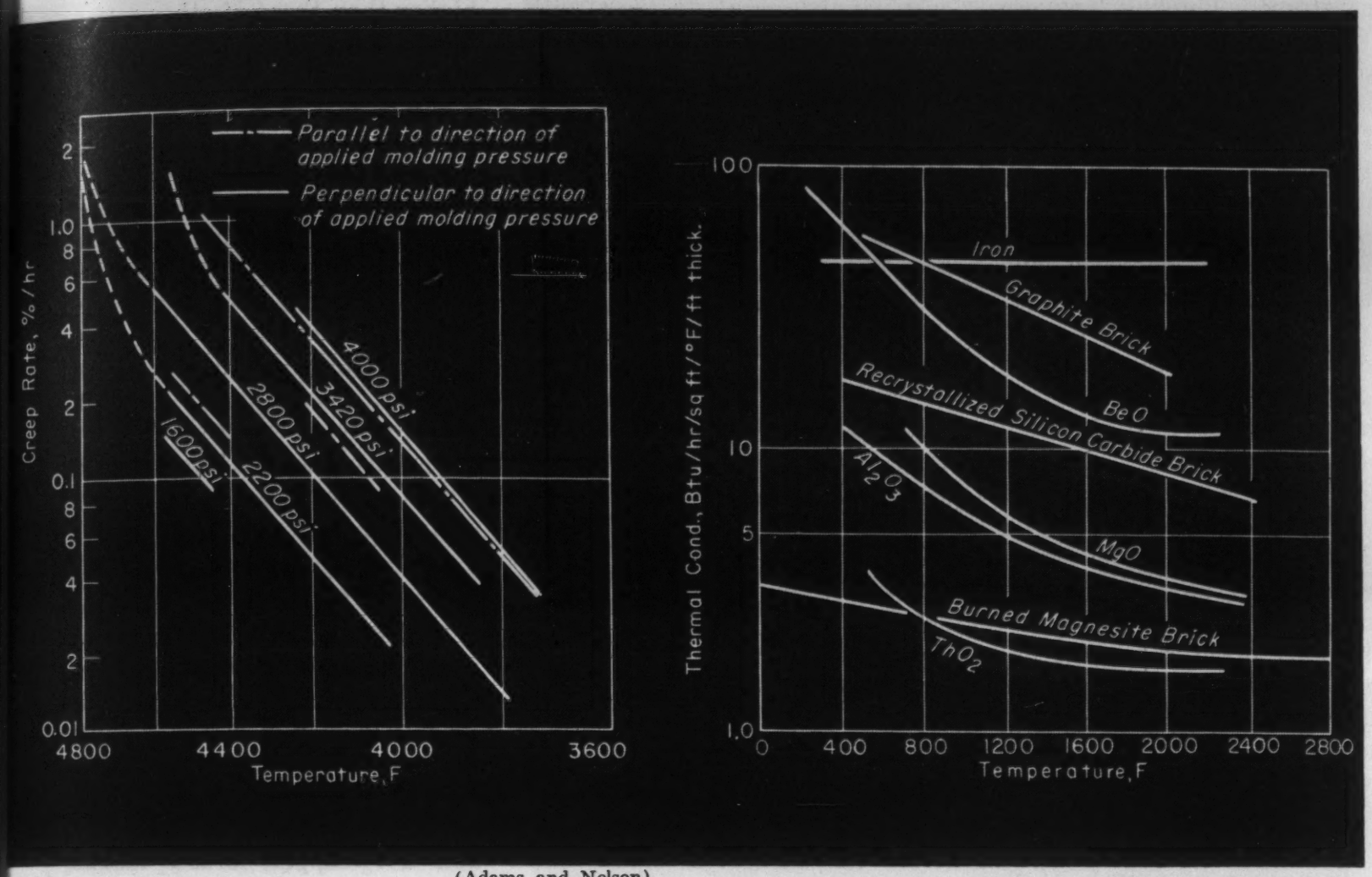
by L. D. Loch,
Battelle Memorial Institute

■ The remarkable properties of graphite as a high temperature structural material have gone relatively unnoticed until recent years, although graphite has long been used in the electrothermic and electrolytic industries. Potential nuclear power and rocket applications have stimulated investigation of its properties at high temperatures. With these data becoming available, design engineers can employ graphite in many cases where superior high temperature stability is required.

There are two general types of graphite products, artificial and natural. However, the natural graphites have limited load-bearing capacity and this discussion is confined to artificial graphites

Physical properties

The properties of artificial graphite reflect the unusual structure of the graphite crystal, which consists of two dimensional layer planes stacked on top of each other like playing cards in a deck. Bonding within the layers is strong and graphite is one of the most stable substances at high



(Adams and Nelson)

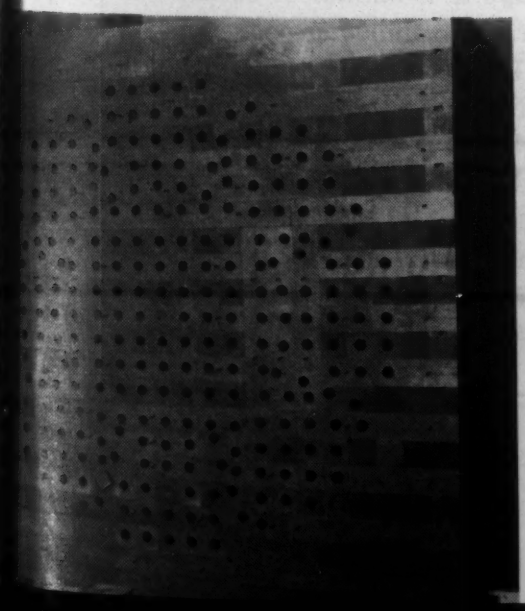
Fig 3 *Creep rates of molded C-18 graphite.*

Fig 4 *Thermal conductivities of graphite compared with other materials.*

At High Temperatures . . .

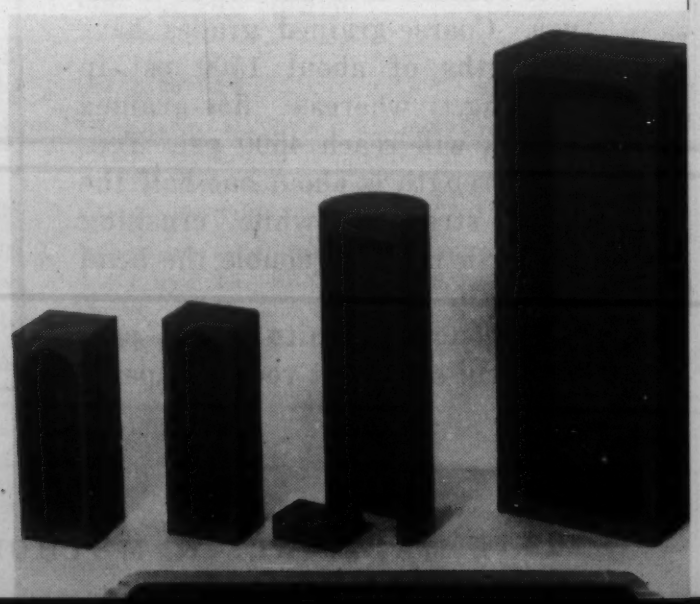
. . . in applications like these

Stack of moderator blocks *for use in nuclear reactor.*



Steel jacketed graphite extrusion canister *for aluminum extrusion. Since graphite retains its lubricity at high temperatures twisting and sticking of the extruded shapes are avoided.* (Speer Carbon Co.)

Graphite crucibles and boats *are used as containers for sintering metal powder parts and (bottom) for zone purification of semiconductor metals.* (Speer Carbon Co.)



temperatures. Bonding between layers is so weak that slip on the basal planes occurs easily and well crystallized graphite is a good lubricant.

Graphite does not melt at atmospheric presure, but sublimes at about 6500 F. It is, of course, not resistant to oxidation and must be used in a neutral or reducing atmosphere or be protected by oxidation-resistant coatings.

The layer type lattice of the graphite crystal gives rise to directional physical properties that show up to some extent in all artificial graphites. The layer planes tend to align in a preferred direction, which is parallel to the axis of extrusion in extruded stock or perpendicular to the direction of the molding force in molded stock. Thermal conductivity and strength normally will be higher in this preferred direction than in other directions.

In discussing the properties of graphite, it is important to point out that each manufacturer produces a large number of grades that are intended for a variety of applications. All are composed of nearly 100% carbon but they differ considerably in physical properties.

Mechanical properties

Mechanical properties of formed graphite vary from piece to piece of the same grade. Variations in strength of 15 to 30% across the diameter of a large electrode are not unusual. For this reason, a fairly large number of determinations must be made to get a true picture of the properties of a particular graphite.

Bend strength is used for control because it is easiest to measure. Coarse-grained grades have strengths of about 1500 psi in bending, whereas fine-grained grades will reach 4500 psi. Tensile strength is about one-half the bend strength, while crushing strength is about double the bend strength.

Although graphite is not particularly strong at room temperature, it becomes stronger with increasing temperatures. Above 3000 F, few materials are as strong. Malmstrom, Keen and Green have reported extensive tests that show that the tensile strength increases up to about 4500 F. Their measurements on five National Carbon Co. grades are shown in Fig 1.

Creep rates of three National Carbon grades have been measured at high temperatures. The results of Malmstrom and associates on extruded ECA are shown in Fig 2. Creep measurements by Adams and Nelson on molded grade C-18 are shown in Fig 3. For comparison, arc cast molybdenum, one of the most refractory metals, has a creep rate of 0.085% per hr at 2000 F and 6000 psi.

Thermal properties

Graphite is an unusual refractory because its thermal conductivity approaches those of the metals. Fig 4 shows that the conductivity of graphite is in the same range as iron and much higher than those of other refractory materials.

This high thermal conductivity combined with low thermal expansion and low elastic modulus gives graphite excellent resistance to thermal shock. In fact, experimental conditions that will fracture it by thermal stresses alone are difficult to devise. Commercial electrodes frequently are withdrawn rapidly from electric-steel furnaces operating at 3000 F. Failure by thermal spalling is never encountered, although small cracks sometimes develop in the surface.

Applications

In Metallurgy—Because of its good machinability and general high temperature stability, graphite is used for dies and molds in continuous casting processes. Graphite is not wetted by most metals and has been found suitable for copper, brass, magnesium, aluminum and high- and low-carbon steels. Metals such as titanium, zirconium, vanadium

How Artificial Graphite is Produced

Production of artificial graphite is based upon the fact that certain carbonaceous materials, notably the petroleum cokes, show extensive crystal growth at high temperatures. This crystal growth is sufficient to produce a polycrystalline material with the desirable thermal and mechanical properties of the graphite crystal without introducing its accompanying weaknesses.

Methods used for preparing artificial graphite shapes are similar to those used for ceramic fabrication. A mixture of filler and plastic binder is extruded or molded, using steam-heated steel dies. In the great majority of cases, the filler is a petroleum coke and the binder a coal-tar pitch. After forming, the shapes are gas baked at 2200 to 2550 F to carbonize the binder. The product is known as *amorphous carbon* or *manufactured carbon* and has many important uses in this form. Conversion to artificial graphite requires an additional step. The shapes are reheated in an electric furnace to about 4800 F to obtain the low electrical resistance and unctuous feel that are characteristic of graphite. The higher the graphitizing temperature, the more like natural graphite the product becomes. Graphitizing temperature and type of petroleum coke or other filler employed influence the properties of the graphite.

Graphite is similar to ceramic materials in finishing operations also. It cannot be rolled, forged, or drawn. Unlike ceramics, though, it is more easily machined than any of the metals. Thus, graphite resembles both ceramics and metals in some aspects of its production and in many of its properties as well.

and molybdenum tend to wet graphite and form carbides but, in spite of this, many of these metals have been melted successfully in graphite crucibles.

Graphite retains its lubricity at elevated temperatures and makes useful canisters for multiple extrusion of aluminum, since twisting and sticking of the hot shapes are avoided.

Graphite crucibles and boats are employed as containers in the sintering of metal powder and carbide parts and as hot pressing dies in the fabrication of many hard metal products.

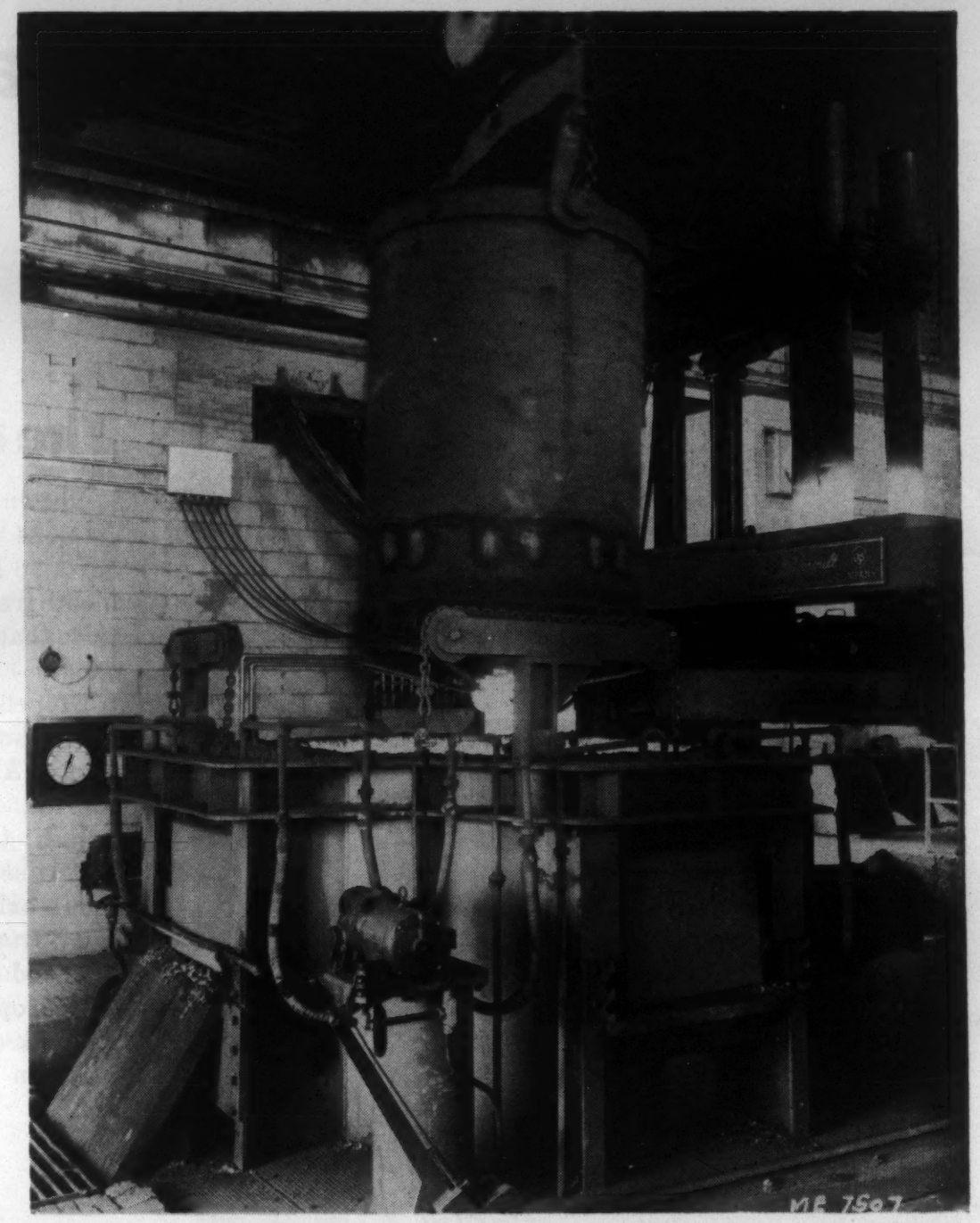
Germanium, silicon and other semiconductor metals are zone purified in graphite boats. Graphite with an impurity content of less than 0.02% is available for this purpose.

In Rockets — The development of rocket propulsion has been extremely rapid in the past few years. Graphite has played an important part in this progress and will continue to do so.

The guide vanes on the German V-2 rocket were made of graphite because it was the only material which would stand up under direct contact with the rocket blast. Similar vanes are used on American rockets.

Combustion chambers of rockets, particularly in the nozzle section, must withstand extreme changes in temperature and the erosive effects of gases moving at high velocities. Graphite has been particularly successful as nozzle material in uncooled solid propellant rockets. In some cases, erosion resistant coatings are required. Suitable coatings based on silicon carbide and molybdenum disilicide have been developed.

In Nuclear Energy—The first nuclear reactor built used graphite as the moderator, or neutron slowing medium. Its chief advantages then were its availability in pure form and its good machinability. The low cost of pure carbon in the form of artificial graphite favors its use in many types of reactors, including those intended for the production of competitive power.



***Graphite** has excellent resistance to thermal shock. Commercial electrodes are frequently withdrawn rapidly from electric steel furnaces operating at 3000 F. Failure by thermal spalling never occurs, although small cracks sometimes develop in the surface.*

A power reactor employing graphite as moderator and liquid sodium as coolant is part of the five year reactor program of the Atomic Energy Commission. Water cooled graphite reactors also appear to have a place in future nuclear power production.

In the future

The materials problem has been the major bottleneck in man's continuing effort to use energy more efficiently. Current developments in the fields of rocket propulsion, turbojet and gas turbine engines, and nuclear power are straining the refractory metals and alloys to their limits. Graphite, on the other hand, offers the possibility of considerable increases in temperature and in efficiency. Its susceptibility to oxidation is a distinct handicap. But if this can be overcome, perhaps with improved coatings, graphite certainly will be a most valuable high temperature material for the future.

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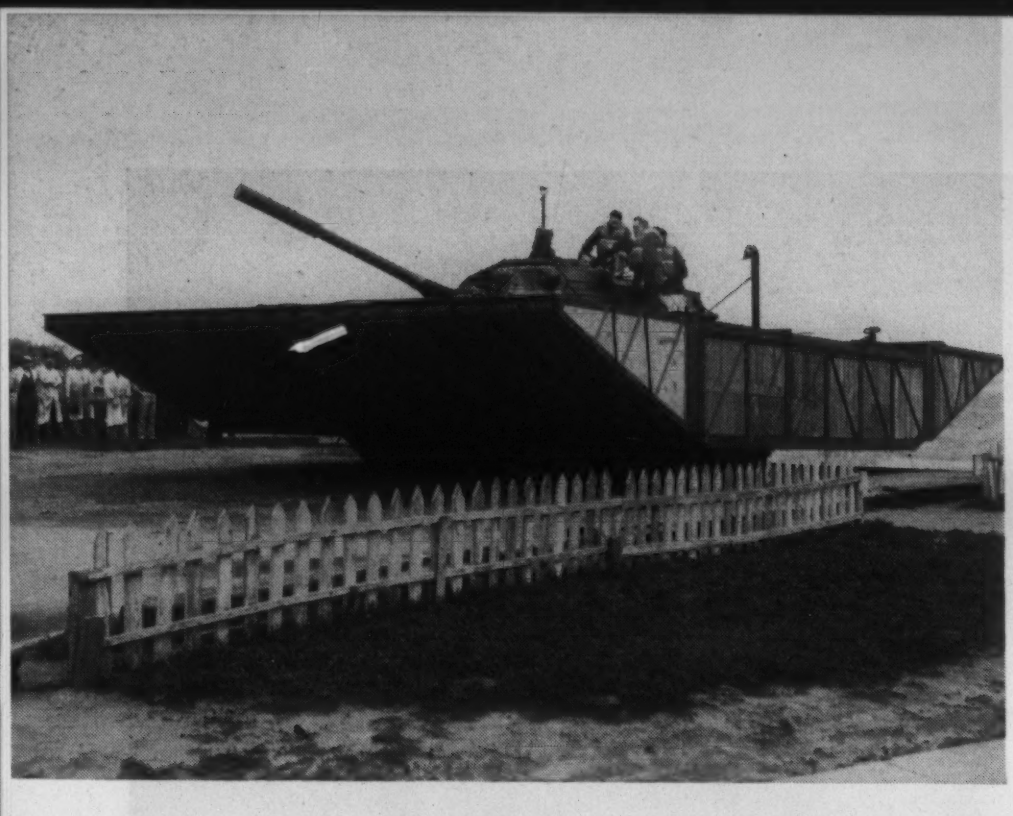
Plastics Keep a 5

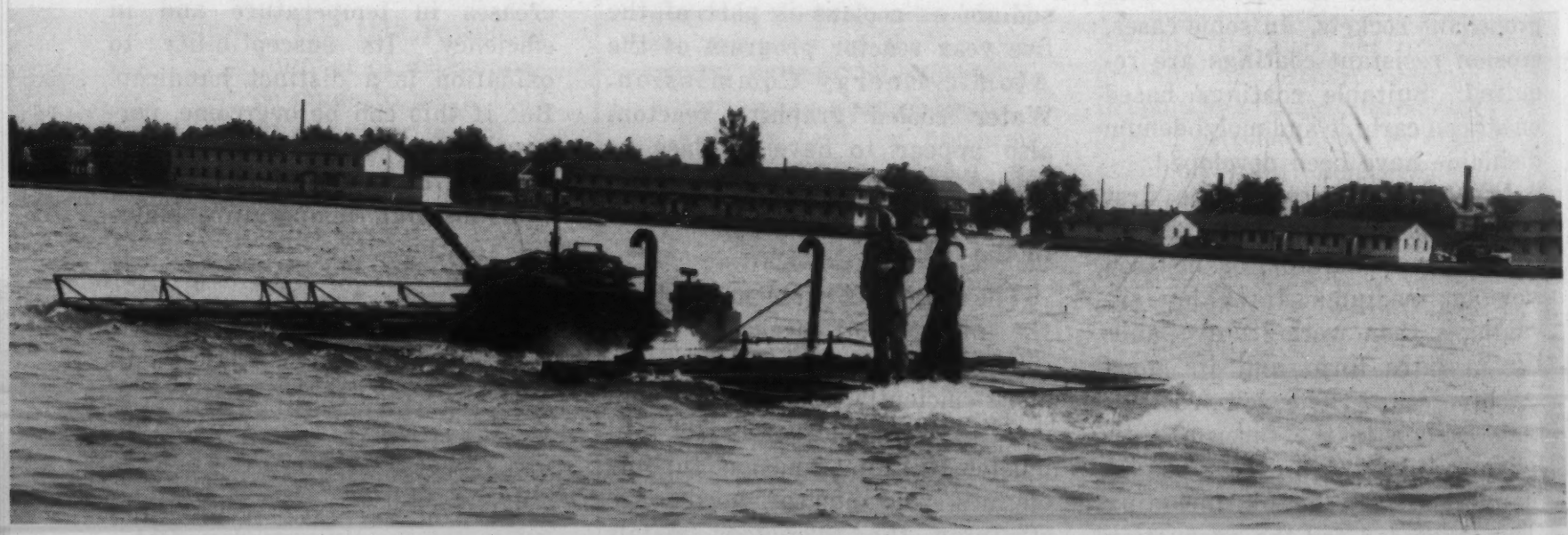


The Float

Shown at the Detroit Arsenal is a 24 x 42 ft flotation device for a 90 MM tank. Set within the metal frame are 43 blocks of plastics that keep the 50-ton tank afloat.

Propellers hooked onto the tank system on each side propel the float. After crossing a water barrier, the driver in the tank pushes two buttons. The first button sets off a charge that drops about half the float. Tank drives away from this dropped end, and a second button sets off a charge that drops the other end. After the tank drives away, parts of the float can be retrieved.

***Tank crew** can install float on tank in a few hours. Here, the side blocks have been installed and the lower block is in place. Groove cut in block helps hold it in place.*



(The pictures on this page are U.S. Army Photographs, Detroit Arsenal)

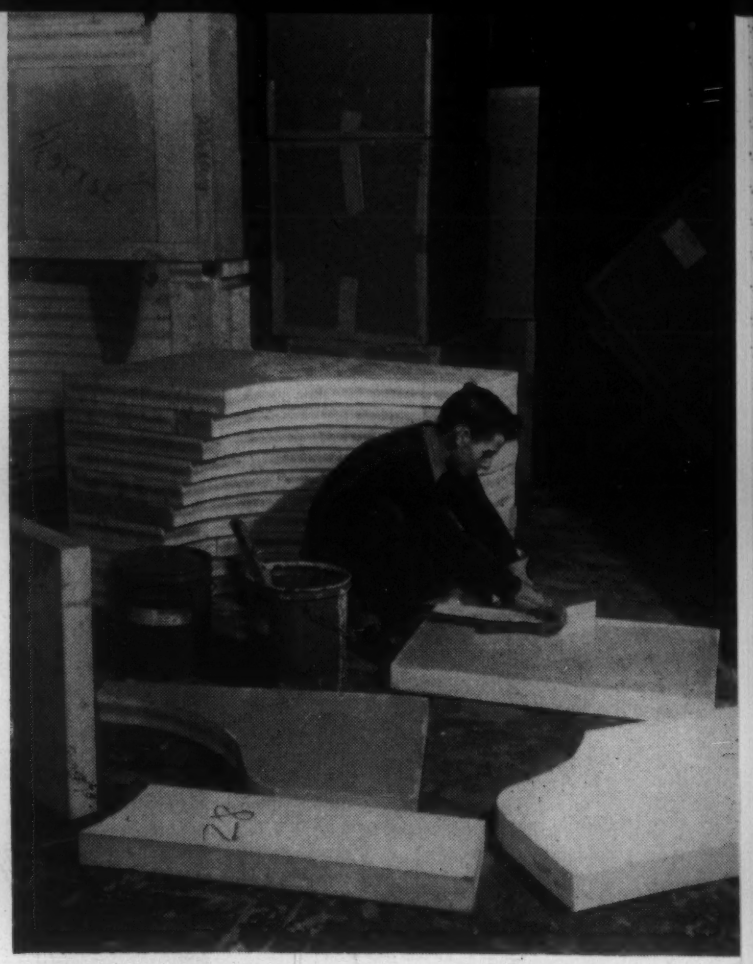
***Finished float** is about 8 ft high with tank inside. Tank float shown in action has surf breaker attached.*

a 50-Ton Tank Afloat

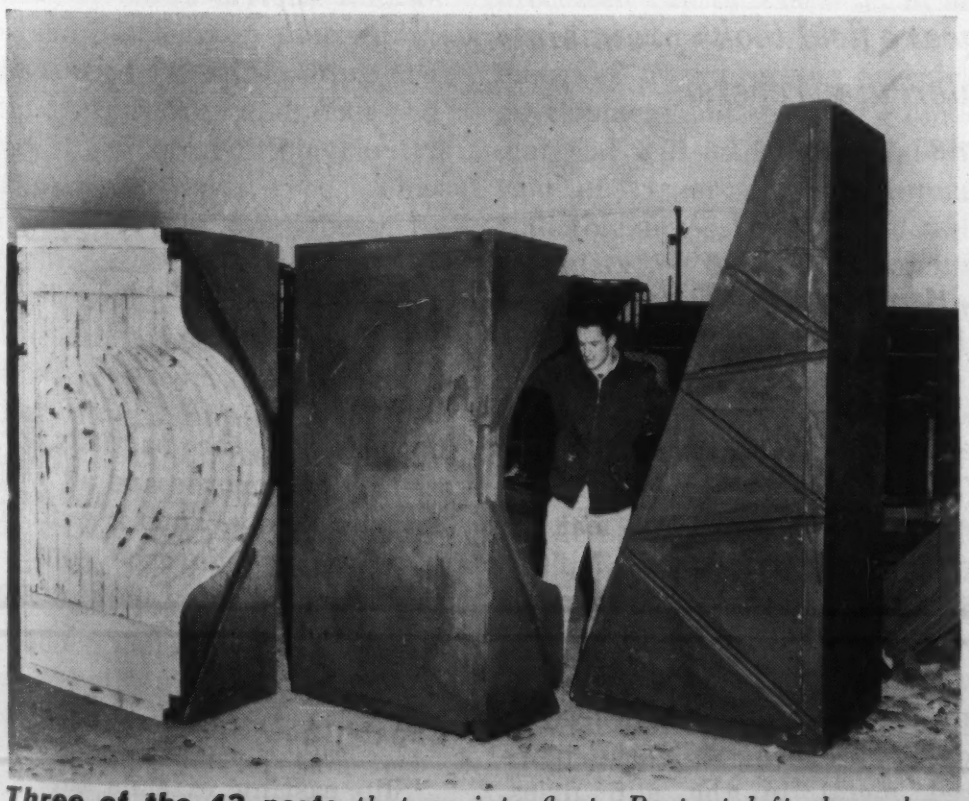
The Plastics

Two types of plastics—vinyl and polystyrene—are used in the blocks of plastics within the metal frame of the tank float. Styrofoam, lighter and less expensive than vinyl, can be used as a fill. Styrofoam, made by Dow Chemical, is an expanded polystyrene. A cubic foot of this plastic will support 55 lb at water level. However, it is very rigid and brittle. If used exclusively, it would tend to break during the rough handling of the blocks. To prevent this, vinyl foam, which is resilient and semi-rigid, is used on the 3-in. exterior ply. The vinyl foam, made by Robinson Molded Plastics, is expanded polyvinyl chloride.

The plastics layers are bonded by a flexible adhesive made by Rubber and Asbestos Corp. Called Bondmaster M650, it is a low-temperature curing, two-part, solvent-dispersed, epoxy-base adhesive.

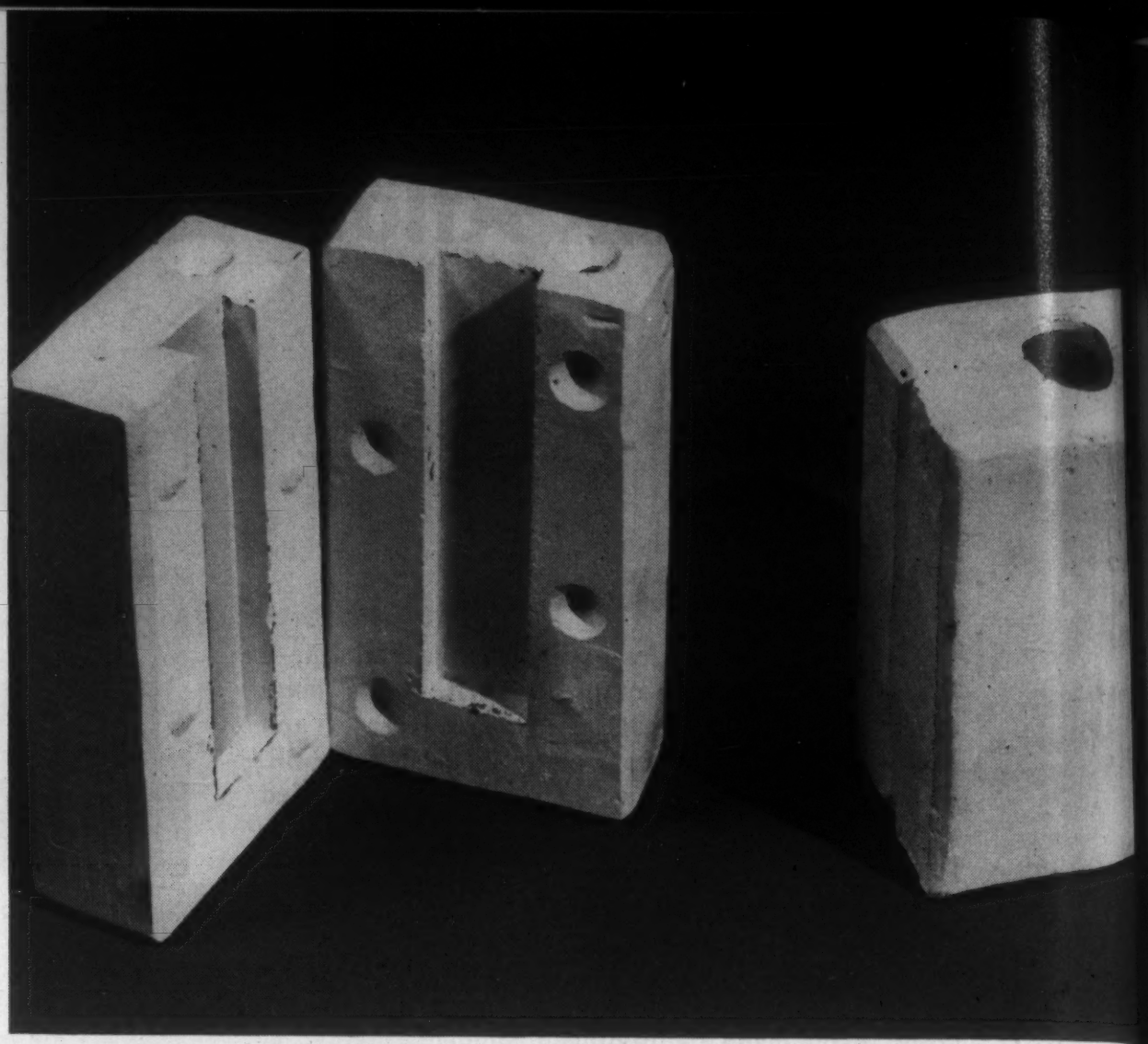


Operator applying bond *to a layer of vinyl plastics foam at Schwab Plastics Corp. Bond sets for 7 to 10 days under room temperature. Parts are painted with neoprene air curing olive drab.*



Three of the 43 parts *that go into float. Part at left shows how layers of plastics are built up. Triangular part is front left outer block.*

Inner core *of plastics block is Styrofoam, light, inexpensive, but brittle and semi-rigid. Outer 3 in. of block are covered by vinyl foam. It is resilient and semi-rigid and prevents breakage during rough handling of blocks. Plastics are bonded by flexible adhesive, called Bondmaster M650.*



Molds *can be made readily from Plaster of Pari*

Cermets,

tungsten,

molybdenum,

stainless steel parts can be made as . . .

Metal Powder Slip Castings

An old process from the ceramic-ware field looks promising for fabricating parts having undercuts, reverse curvatures and lateral projections.

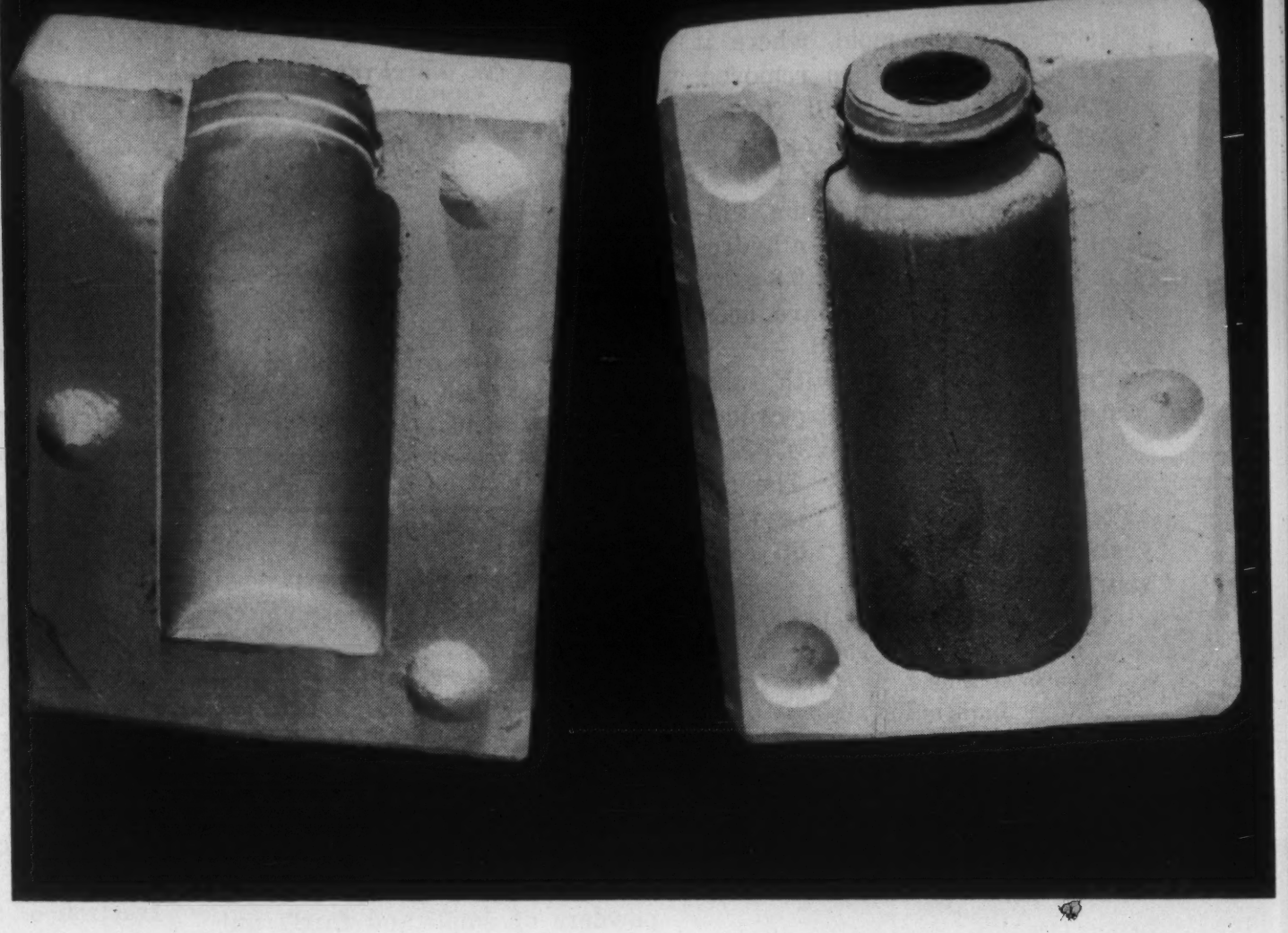
by Henry H. Hausner, *General Manager, Nuclear Engineering Div., Penn-Texas Corp.*
and Donald P. Ferriss, *Powder Metallurgy Lab., Stevens Inst. of Tech.*

■ Slip casting has long been established in the field of ceramics as a method of molding ceramic ware of large dimensions or complicated shapes. Now this method is being adapted to the production of metal powder shapes. It merits serious consideration as a new powder metallurgy process and the development work is in progress in several organizations.

To slip cast metal powders, the same procedure used for making ceramic ware is followed. A fluid suspension of metal powder in liquid is poured into a Plaster of Paris mold. The porous mold permits the liquid to penetrate and be absorbed while the powdered metal in the slip dries within the mold. The mold is then opened and the partially dried casting is removed and allowed to dry completely. Then it is fired in a sintering furnace until it reaches the desired physical properties.

Capabilities

Slip casting extends the scope of parts which can be fabricated



ttle shapes *can be slip t from stainless steel wder.*

y powder metallurgy. Ordinary ompacting and sintering techiques restrict the shape and size f a part to that which can be ompacted under unilateral pressure in a die. While hydrostatic ompaction of powders is quite easible, it offers serious limitaions and problems in processing.

Molds used for slip casting are uite inexpensive and can be ither single or multiple cavity, sually of the split type. This mmediately opens the process to e fabrication from powders of any shapes which ordinarily annot even be considered. Undercuts, reverse curvatures, lateral rojections and cores may be designed in the Plaster of Paris olds. The common practice in eramic slip casting of pouring ut the center of the slip before t has fully settled may be used o produce hollow shapes such as ubes, bottle-shaped compacts, ollow spheres. One very interesting modification of this technique is the fabrication of hollow ubes having a porous or solid wall depending on subsequent processing.

The maximum size of parts is dictated by the facility with which the green part can be handled. While at this time only relatively small parts may be processed (up to 5 or 6 in. in any one dimension), further development of the process, especially development of correct binder material will lead to the fabrication of larger parts. Minimum wall thicknesses will be a definite consideration because of handling problems and differential shrinkage between thin and heavy sections during sintering.

Because the extremely fine powders, which must be used, have high surface energy and sinter readily under suitable conditions, considerable shrinkage during sintering is experienced. This dimensional change is one of the characteristics which must be studied and compensated in order to open the process to parts which require close dimensional tolerances.

Metals and cermets

Slip casting may be of special interest for fabricating metal-ceramic combinations, such as those known under the term *cermets*. A. R. Blackburn and T. S. Shevlin applied this method in their research on chromium-aluminum oxide cermets as early as 1948. Their interest was concentrated on a 30% Cr-70% Al_2O_3 mixture. Water was used as the liquid for suspension of the powder particles, and the solid-liquid ratio was 3 to 1 by weight. Jet engine nozzles and other high temperature parts were prepared by this method.

Slip casting has been applied also to refractory metal powders, such as tungsten and molybdenum (British patent No. 649203). Wet milling of the powder is followed by leaching with acid, preferably in stages, starting with relatively strong acid, e.g., 10% (by volume) HCl. After the final leach, and decanting of the acid, the slightly acid slurry left is cast in to

Plaster of Paris mold, where it is allowed to dry, then removed, further air-dried, and finally dried by careful heating to a maximum temperature of 230 F. In the case of molybdenum, sintering is done at 3100 F in hydrogen. Resultant density is 9.8 g/cc. Molybdenum crucibles have been produced by this method.

Preliminary tests with slip casting of stainless steel powders were recently made by W. C. Lidman and R. V. Rubino. The results are encouraging. These investigators prepared a slip consisting of:

75.2% stainless steel powder (302B) of —100 mesh size
0.25% elvanol
0.35% ammonium alginate
24.2% water.

The sample cast with this slip was sintered at 2400 F for 7 hr in hydrogen and was characterized by the following physical properties:

Density	6.62 g/cc
Ultimate tensile strength	70,500 psi
Yield strength (0.2% offset)	40,200 psi
Elongation	20%

The data given by Lidman and Rubino are not completely informative inasmuch as these authors did not specify precisely the powder particle size distribution, but indicated that a higher percentage of fine particles resulted in a sample of 7.08 g/cc density.

Process details

Established processes of powder metallurgy are complicated because of the many variables involved. Slip casting is even more complicated. One of the greatest difficulties is the nonuniform settling rate of metal powder particles of various sizes and shapes. Stokes' Law indicates some of the more important variables determining the settling rates of spherical powder particles in liquids. According to Stokes the settling speed of a spherical particle depends on its diameter and density and on the density and viscosity of the liquid in which the particle is suspended. The smaller the particle diameter and the greater the density and viscosity of the liquid, the smaller is the settling speed. For slip casting, segregation of particles of various diameters before pouring the slip into the mold should be at a minimum.

STOKES LAW INDICATES PROCESS VARIABLES

$$S = \frac{d^2(P_1 - P_2)g}{18\mu}$$

Where S = velocity of powder particles
d = dia of suspended particle
g = 981 cm/sec²
P_1 = density of powder particle
P_2 = density of liquid
μ = viscosity of liquid

This can be prevented by using powders of small and fairly uniform particle size, and by keeping the density and viscosity of the liquid high. Fine powder particles have the further advantage that they sinter faster because of the rather high surface area/volume ratio, which results in high surface activity. Fast settling of particles in the liquid can be prevented by increasing the density and viscosity of the liquid with the help of deflocculents. Blackburn and Shevlin, in their tests on chromium-aluminum oxide slip castings, added 1 to 1½% ferric chloride as a deflocculent. In ceramic slip casting, deflocculents, such as soda ash or ammonium silicates, are added.

Considering the above, the following variables are of prime importance in slip casting metal powders: a) density of powder particles; b) process of powder production; c) powder particle shape, porosity and diameter; d) powder particle surface conditions; e) reaction of the powder with the liquid; f) density, viscosity and temperature of the liquid; g) ratio of solid to liquid; h) amount of air entrapped in the slip; i) type of deflocculent; j) rate of drying in the die, which depends on material of the mold, and porosity of the mold material; k) rate of drying after removal from the die; l) sintering conditions including rate of heating, temperature, time and atmosphere.

This list is by no means complete. The variables listed, numerous as they are, however, are controllable and will definitely permit a fairly high degree of precision in slip casting.

The design for the mold and mold material are of great importance for the process. The requirements for the mold are: a) sufficient strength; b) ability to absorb moisture; c) ease of releasing compact after drying.

Plaster of Paris, is an excellent mold material. In order to improve the releasing properties of the mold, certain additions can be made to the plaster such as a fraction of a percent of graphite or sand. In many cases, coating the mold surface with a soap solution permits easy release of the metal powder compact. Mold temperature during slip pouring and drying also strongly affects the properties of the compact.

Another important property of the slip is its viscosity, which indicates fluidity, ease of pouring and ability to fill the mold completely. Viscosity is determined to a certain extent by the amount of solids in the liquid and changes rapidly with variation in temperature. Water, for example, has a viscosity of 1.0 centipoise at 68 F, but only 0.66 centipoise at 104 F. Thus, the use of warm water makes a casting slip more fluid.

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L. Delisle, "Bonding Metal Particles by Heat Alone Without Pressure", Electrochem. Soc. Trans. *85* (1944)

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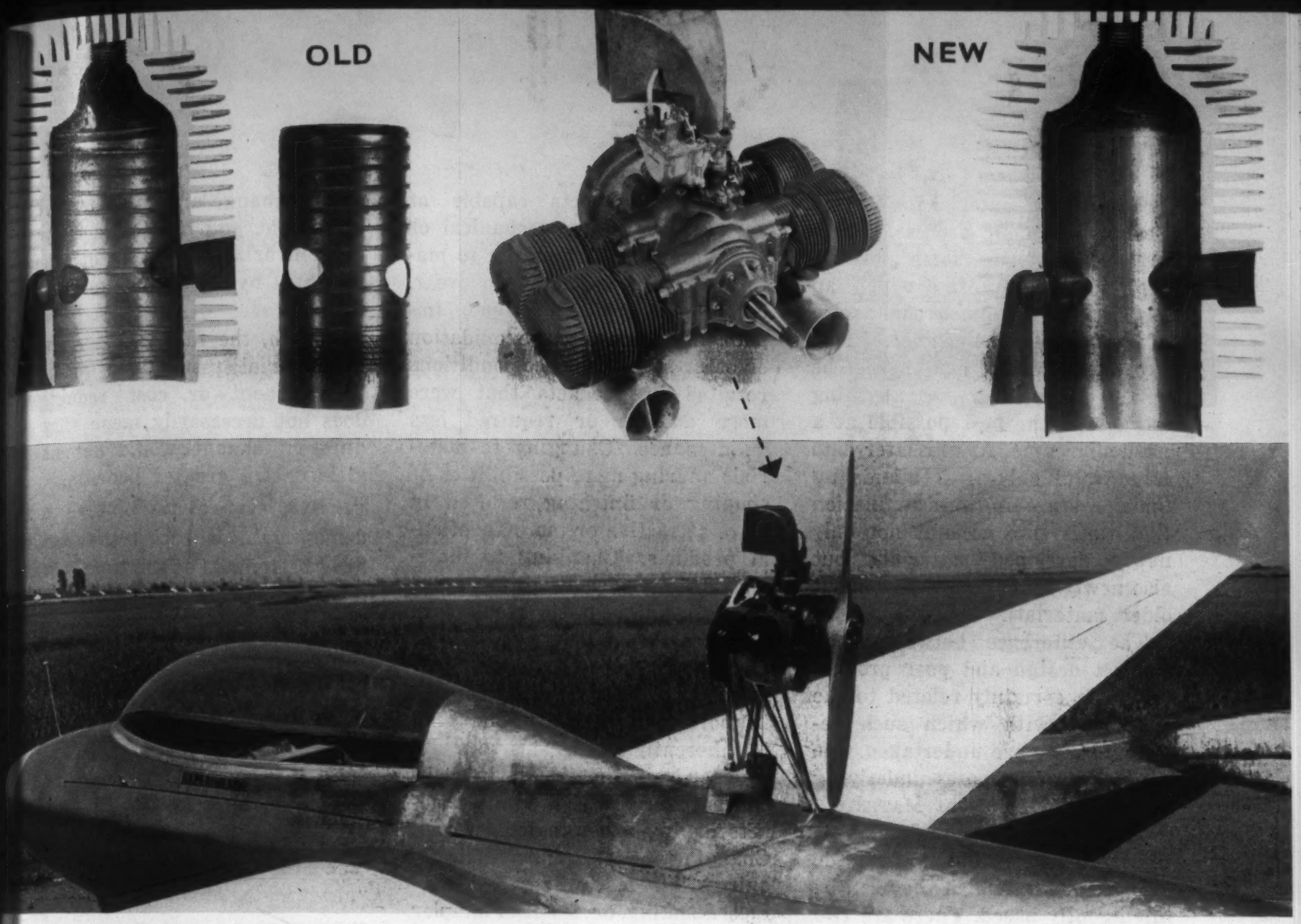


Materials changes *reduced weight and improved performance in this auxiliary powered glider.* *See page 155 for complete details.*

Improve Quality, Reduce Costs, through Better Materials Selection

A Special Report

Here are 64 case histories showing where and how intelligent selection and use of engineering materials resulted in:

- *Longer service life*
- *Improved product performance*
- *Lower materials costs*
- *Simpler, less costly fabrication*
- *Reduced maintenance costs*
- *Greater design flexibility*

Introduction

■ Selecting a material for a product is a dynamic process. There are many avenues, some more direct than others, by which an engineer or designer can arrive at an intelligent choice. This choice, however, can never be safely assumed to be anything more than the best possible at a particular time. At any later date it is valid only if it stands up under a searching re-examination that takes into account not only newly developed materials, but also newly found knowledge about older materials.

The difference between good product design and poor product design is certainly related to the frequency with which such re-examinations are undertaken. One of the major purposes underlying the editorial policy of MATERIALS & METHODS is to stimulate these re-examinations and to provide information on which they can be intelligently based. There are two methods of accomplishing this aim:

1. Report comprehensively on properties and applications of new materials, on ways of making better use of older materials, and on ways of selecting the optimum material to meet various service conditions.

2. Report on the materials decisions made by manufacturers of products similar to those made by others among our readers.

In this special article, we take the second approach. For the third year in a row, we present a collection of case histories that show what happened when other manufacturers stopped to re-examine *their* selection of materials.

Why change?

The results achieved by the changes described in these case histories fall into two general categories: improved quality and lower cost.

Improved quality was achieved in many different ways. Changing to materials having greater mechanical or dielectric strength resulted in products capable of sustaining greater mechanical or electrical loads. Changing to materials more resistant to wear, corrosion, erosion, fatigue, impact, high temperature oxidation or other special service conditions resulted in products that were more durable or required less maintenance. Changing to materials offering more possibilities of shaping or finishing resulted in more attractive or more functional products. Changing to materials of lower density or of higher strength-weight ratio resulted in products that were more saleable or less expensive to operate.

Lower costs were also achieved in more than one way. Changing to inherently less expensive materials or using materials in more efficient forms resulted in products having lower materials cost. Changing to materials that required less machining, less surface finishing, or fewer or simpler assembly operations resulted in products having less overhead or labor cost.

Some cautions

Our previous case history presentations have been favorably received by many readers, and we hope this year's collection will prove equally interesting and helpful. However, the case history approach has its natural limitations of which the reader should be aware.

First, a change that is right for one manufacturer may not be right for another. For example, a change intended to eliminate the labor cost involved in assembly operations may not be justifiable in a plant where wage levels are lower.

Second, differences in the abilities of engineers and designers, in material acceptance standards and in control of quality during manufacture make it impossible for all manufacturers to secure equal advantages from any given material.

Third, the advantages resulting from a change are, in some cases, intangible, and intangible factors are invariably given different weights by different manufacturers.

Fourth, the fact that a change in material resulted in product improvement or cost reduction does not necessarily mean that a different change would not have yielded still greater benefits.

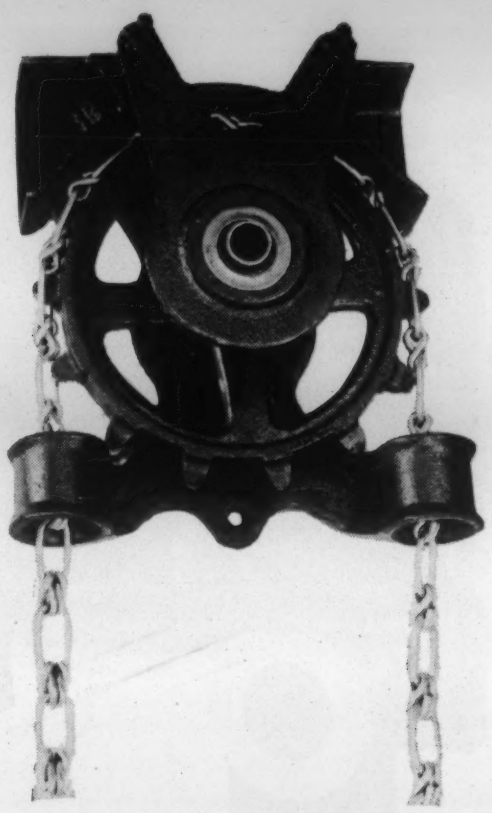
Fifth, even if the change was demonstrably the best that could have been made at the time it was made, a certain amount of time has since elapsed, and a more advantageous change might now be possible.

So it is obvious that no case history of the type presented here can be regarded as universally valid. At most it can stimulate re-examination of product design and suggest investigation of the "new" material for the particular application described and for somewhat similar applications. In planning this article, we have tried to keep these simple objectives foremost.

One final caution: Whenever we emphasize replacement of one material by another, we risk being accused of advocating, through favoritism or ignorance, the general superiority of the new to the old. We do not so advocate. In fact, we will go further. It is undoubtedly true that some products have been redesigned capriciously and some new materials used most unwisely. Although we believe the engineer should and must learn to use the newer materials that have been made available to him, we also believe that he is foolish indeed if he allows nothing more substantial than unsupported claims or the appeal of novelty to turn him from an older material that has proved itself over a period of years. Let's face it: Constant vigilance is necessary, but sometimes it is just plain good engineering to make no change at all.

Timing Gear Sprocket

Saving in metal



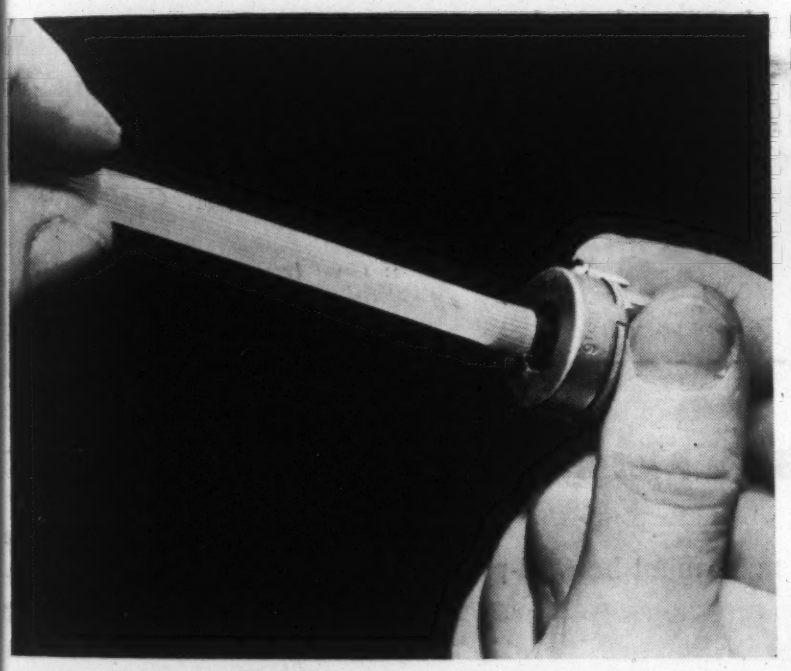
Automotive timing gear sprocket must have good strength and wear resistance.

Old Machined and fabricated from steel bar stock.

New Pearlitic malleable iron casting, coin pressed and machined.

Advantages Gained Casting weighed 1.43 lb as contrasted with 2.29 lb for bar stock. Two surfaces were coined and required no machining. Casting also improved vibration damping properties.

Source: *Malleable Founders' Society*



Extension Shafts for Instrument Control

Provide lower costs

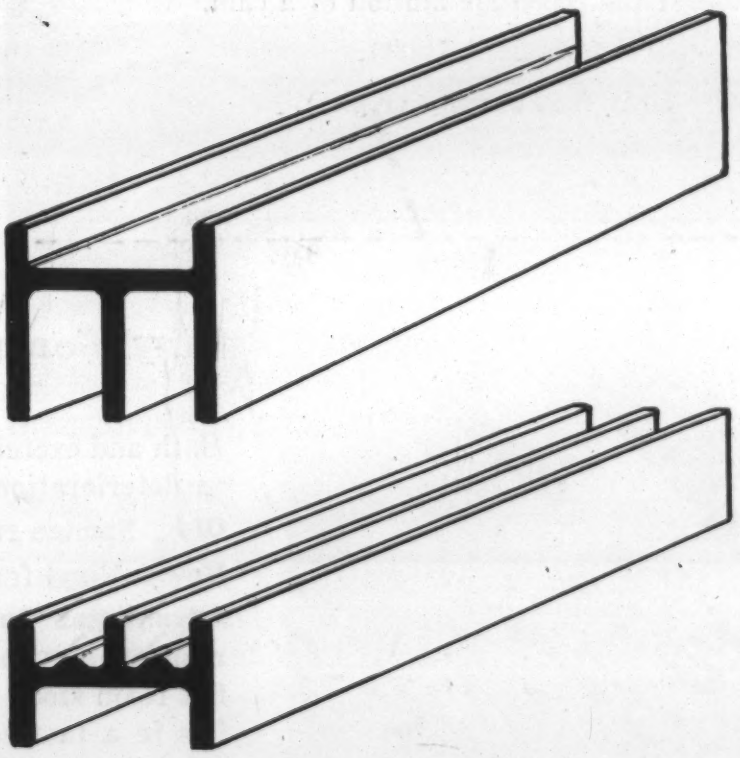
Extension shafts for such mass-produced items as radio and TV sets must be low in cost and provide adequate flexibility or rigidity as the application demands.

Old Plated brass and molded fiber.

New Depending on application, modified polyethylene shafts are available in flexible and rigid tubular extrusions.

Advantages Gained Lower unit costs—1.2 and 1.8¢ for 6 and 10½ in. shafts respectively. Extensions provide increased flexibility for remote control of instruments and potentiometers and other inaccessible electronic components. Shafts are moisture resistant and provide excellent insulation.

Source: *Anchor Plastics Co.*



Tracks for Sliding Panels

Reduced friction

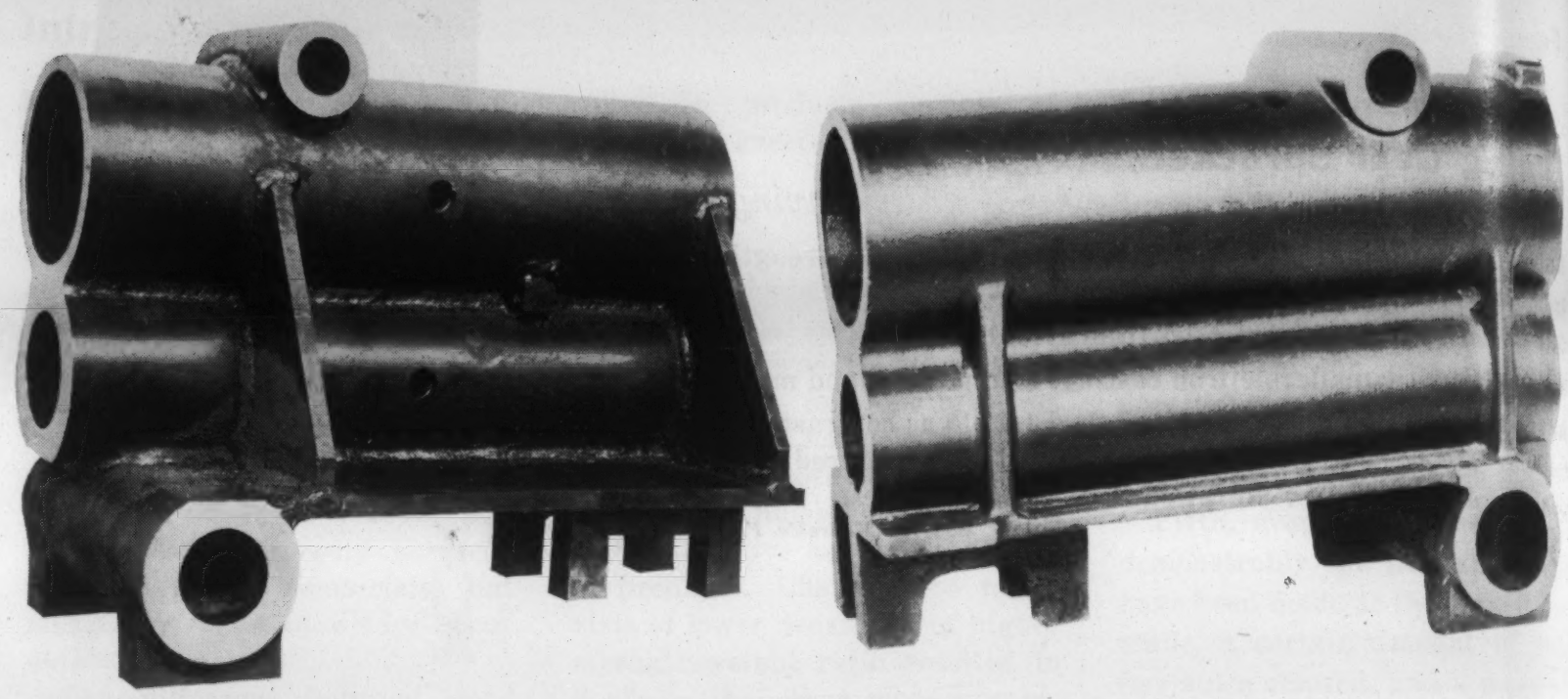
Extruded tracks used as runners for sliding doors, mirrors and panels of glass, hardwood and plywood.

Old Aluminum.

New Modified polystyrene (Ancorene).

Advantages Gained Lower material costs plus decreased assembly times. Material is easily worked and is installed with adhesive or small nailing strips. Channels can be colored to match any cabinet decor. Convex platforms on lower tracks reduce noise and lower friction without the use of special rollers or bearing strips. Material has high impact strength, resists chipping, warping and splintering and will not corrode.

Source: *Anchor Plastics Co.*



Spindle Housing

Production time reduced

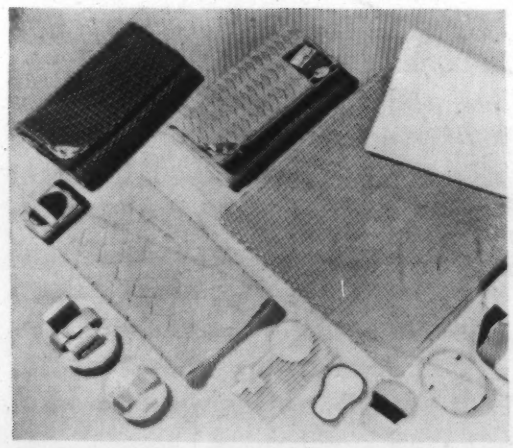
Part requires close tolerances in the large bore because of the eccentric motion of a cam.

Old Steel weldment (left).

New Gray iron casting (right).

Advantages Gained Old part required 7 to 8 wk from requisition time to assembly on machine, new requires approximately one week. Total machine shop time reduced from 54 to 20 hr. Cost saving $108.90 per machine.

Source: *Gray Iron Founders' Society, Inc.*



Vinyl Foam Bath Mats

Deterioration reduced

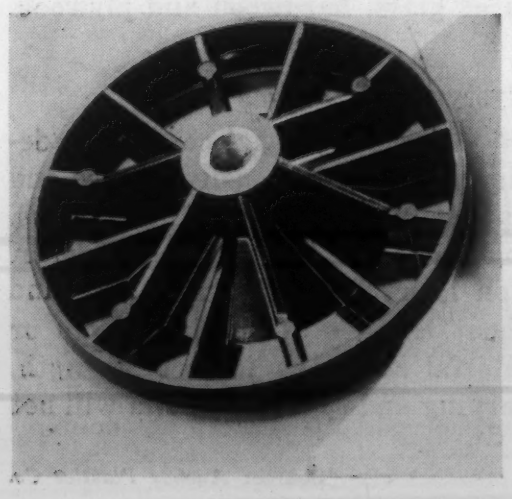
Bath and exercise mats must be skid-proof, easy to clean and impervious to deterioration.

Old Sponge rubber.

New Vinyl foam to which a skin of vinyl film is electrically heat-sealed.

Advantages Gained New material does not oxidize and has excellent resistance to soap and water. Heat sealing makes it possible to join the flat foam stock to brightly colored and deeply embossed covering materials in a fast economical operation.

Sources: *Elastomer Chemical Corp.; Bolta Products Div., General Tire & Rubber Co.*



Fan for Washing Machine Motor

Machining operations eliminated

Cooling fan for motor is about 6 in. in dia. Part must be durable, light and economically manufactured.

Old Aluminum sand casting.

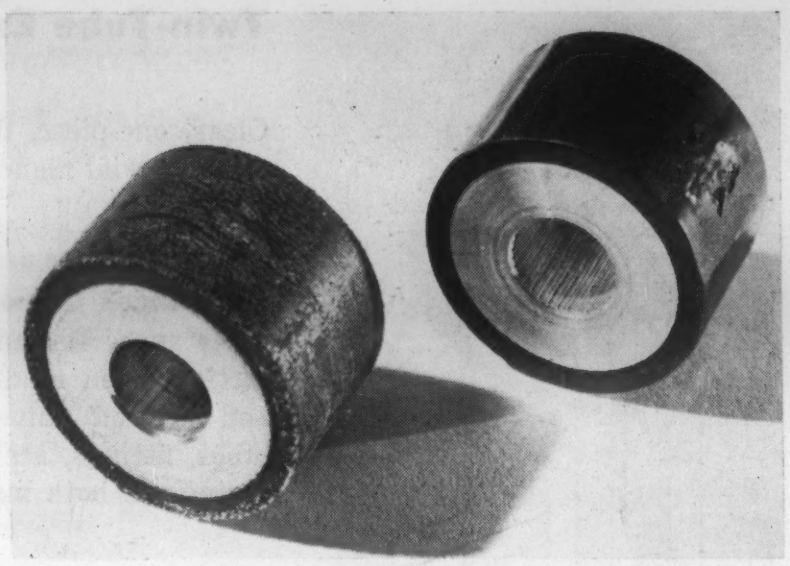
New High-impact, general purpose phenolic.

Advantages Gained Phenolic fan is lighter, needs no balancing or machining prior to assembly on motor shaft. Elimination of drilling, reaming and balancing operations previously required has resulted in reduced costs.

Source: *Hooker Electrochemical Co.*

Feed Rolls

Wear life prolonged



Feed rolls for high speed, punch card data processing equipment. Punch cards are handled at rates up to 800 per min.

Old Gum rubber compound (right).

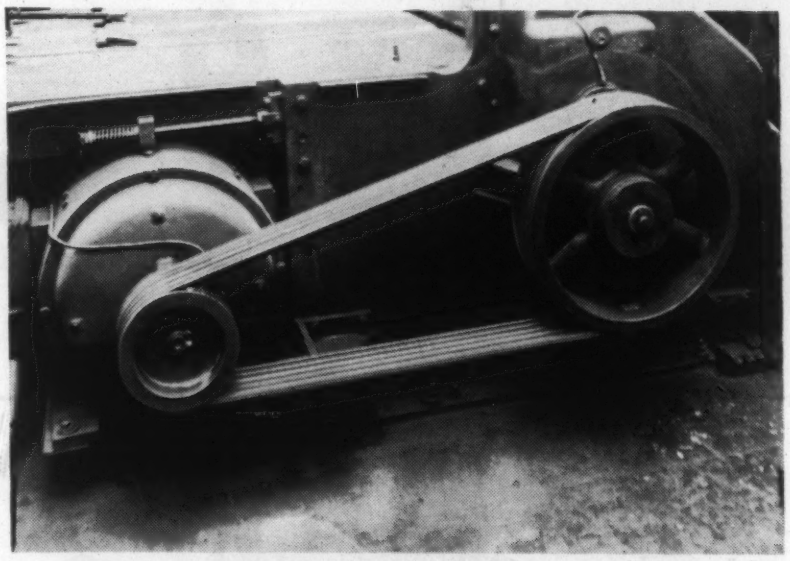
New Alternate washers of neoprene and neoprene impregnated cotton fabric bonded and vulcanized to shaft (left).

Advantages Gained Wear life increased twenty times, materially offsetting increase in roll cost. Improved functional performance was also obtained.

Source: *Remington Rand, Div. of Sperry Rand Corp.*

V-Belts for Industrial Drives

Wear life increased



Multi-belt, 30-hp drive for 60 x 140 in. printer-slotter used in manufacture of corrugated packing boxes and shipping containers. V-belts must have high strength, impact resistance and flex life. Also, low stretch and dimensional stability (for easy matching). Installation must withstand frequent shock loads and severe paper dust conditions.

Old Rayon reinforcing cords imbedded in synthetic rubber.

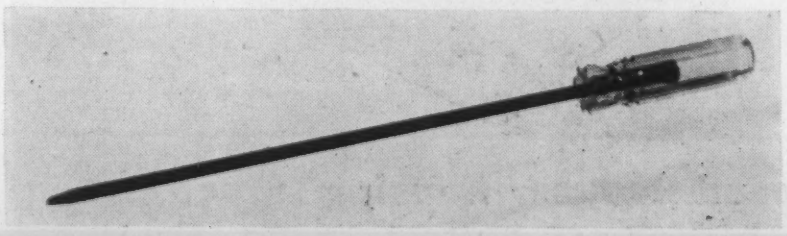
New Polyester fiber cords (Dacron) imbedded in synthetic rubber.

Advantages Gained Longer life. In printer-slotter, Dacron belts have lasted 6 times as long as conventional belts—3 yr versus 6 mo—and are still in excellent condition. Units transmit up to 40% more hp and save space (generally, 5 Dacron V-belts replace 7 standard belts). New belts minimize take-up, rematching and maintenance and possess good dimensional stability and low stretch. Material resists abrasion, heat, oil, acids and most alkaline materials. Despite higher unit costs of premium belts, total installation costs are usually lower because of the fewer number of belts required.

Source: *E. I. du Pont de Nemours & Co., Inc.*

Insulated Screwdriver

Strength increased



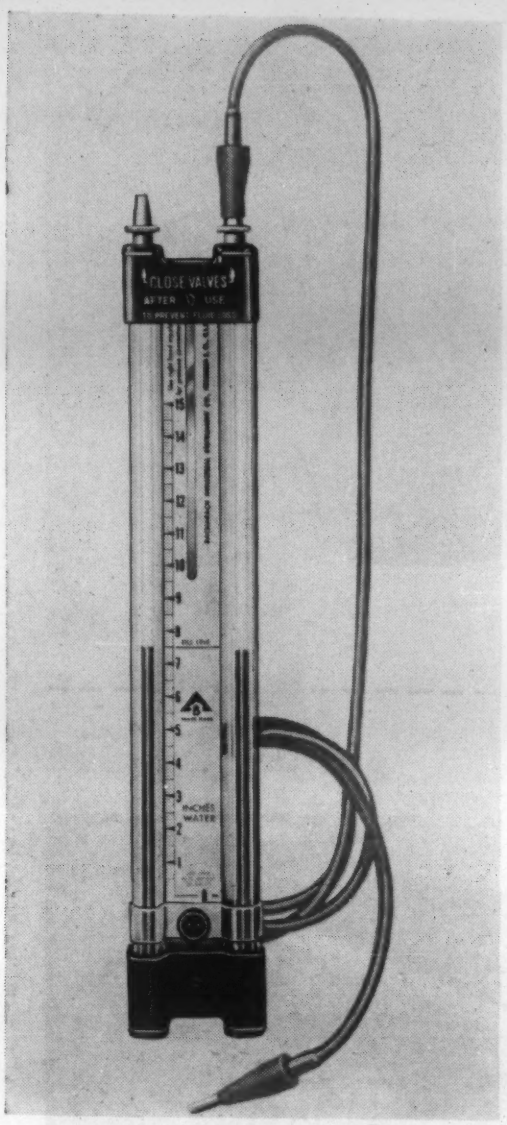
Rod for an insulated screwdriver for electronic work is 5/16 in. in dia and approximately 8 in. long. The blade as well as the handle must be made of an insulating material. It must be strong enough to resist permanent deformation, and tough enough to withstand rough handling. Material must be machinable to allow easy grinding of point of driver.

Old Vulcanized fibre.

New Glass-reinforced polyester rod.

Advantages Gained New rod is stronger, has better electrical insulating characteristics, has a low moisture absorption and will not warp or take permanent set. It is available in variety of colors for improved sales appeal.

Source: *Taylor Fibre Co.*



Twin-Tube Extrusion for Manometer

Fewer parts required

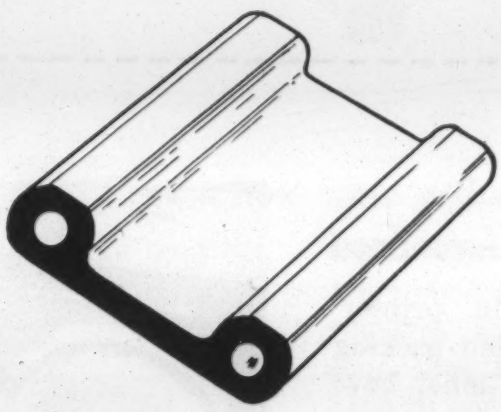
Clear, one-piece, dual-tube extrusion forms main construction element of industrial manometer.

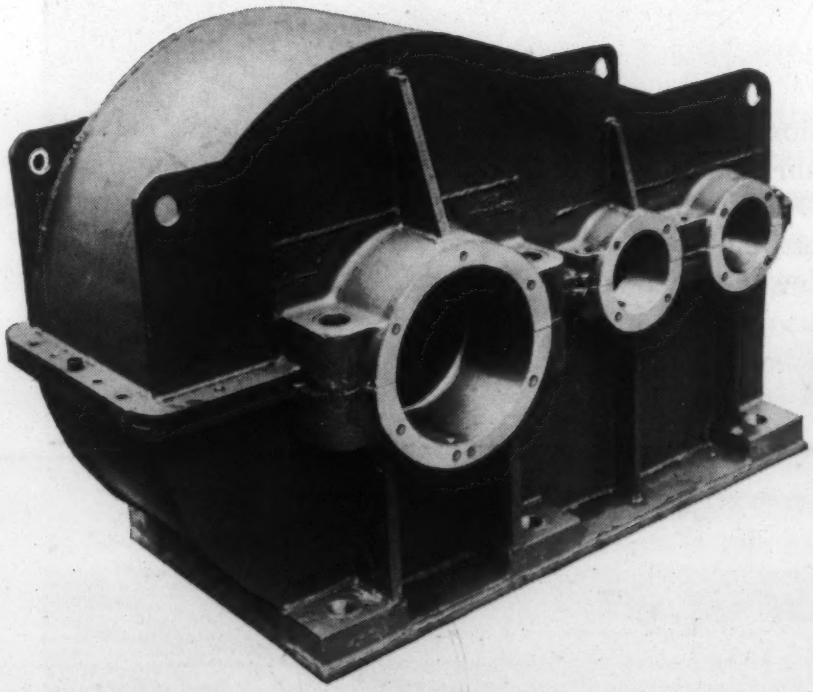
Old Glass.

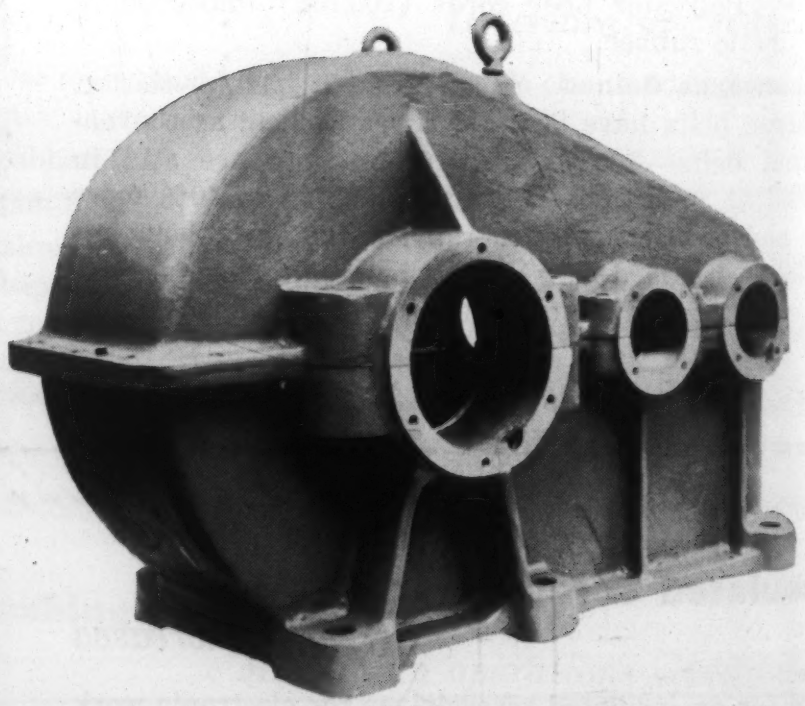
New Cellulose acetate butyrate.

Advantages Gained Integral center web of 2-in. wide extrusion provides space for adjustable scale. Flats on tube surface eliminate distortion when reading liquid level. Two moldings containing ball-check and shut-off valves complete the assembly. Elimination of separate tubes, fittings, scale backing and other hardware provides considerable savings in both materials and assembly time.

Sources: *Anchor Plastics Co., Inc.; Bacharach Industrial Instrument Co.*







Speed Reducer Housing

Fabrication simplified

The unit requires adequate strength and should damp vibrations to reduce noise level.

Old Welded assembly of 69 individual parts (left).

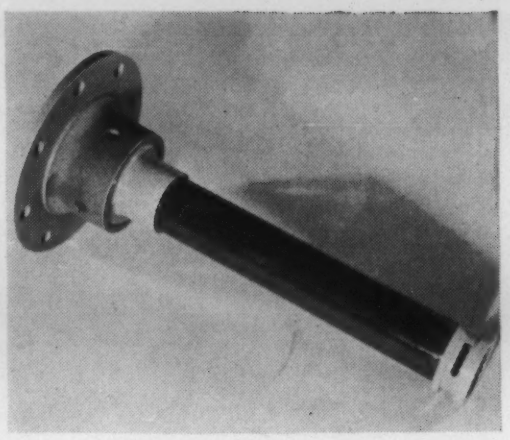
New Two gray iron castings (right).

Advantages Gained Iron housing saved 73% on cost of unmachined pieces and 20% in machining costs. Iron reduced vibration and noise level of unit.

Source: *Gray Iron Founders' Society*

Aircraft Fuel Gage Tube

Size and weight reduced



Tubing for aircraft fuel gage tank unit has an approximate 3/4 in. o.d. and is 6 in. to 8 ft long with a 3/64 in. wall thickness. Must resist corrosive action of fuel. Must also be light-weight and resistant to structural fatigue due to vibration and shock. Redesigning component imposed requirement that tube material be a good electrical insulator.

Old Aluminum tubing.

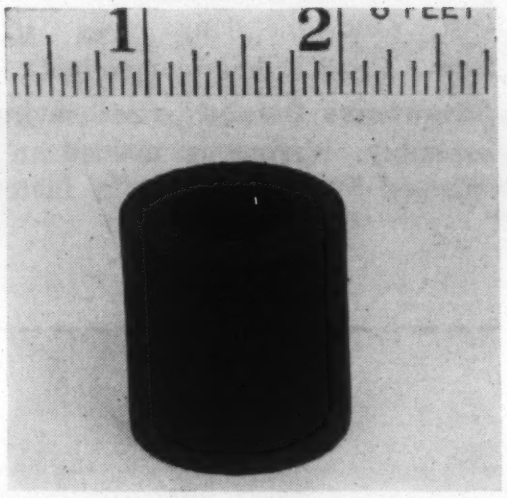
New Glass-reinforced epoxy resin laminate.

Advantages Gained Use of epoxy laminate permitted redesign resulting in a component of smaller size, lighter weight and greater reliability. Maintenance and overhaul are simplified.

Source: *Taylor Fibre Co.; Avien, Inc.*

Casting Ladle Insert

Better erosion resistance



Part is subjected to erosion and thermal shock, should not be wet or attacked by the copper alloys being poured.

Old Metal shell lined with refractory cement in which pouring holes were formed.

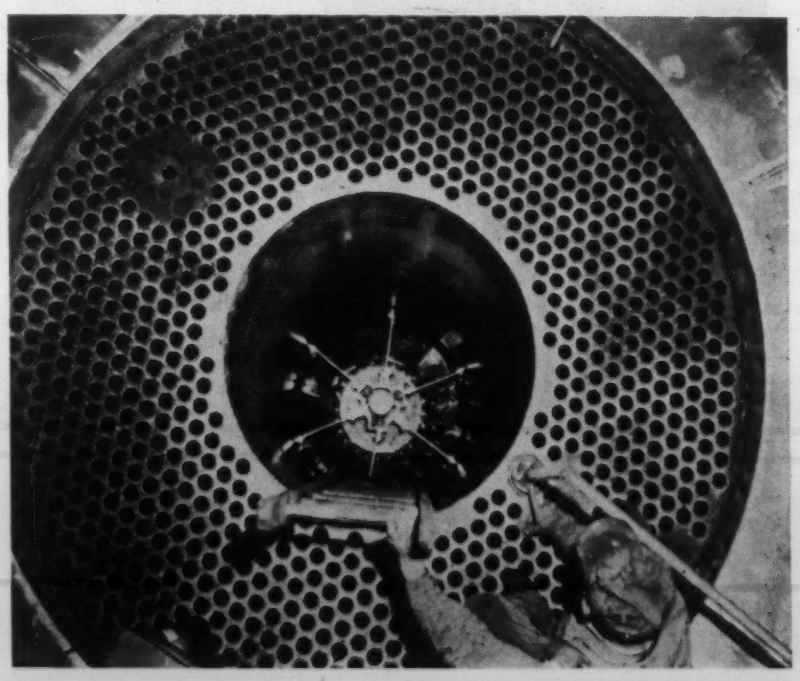
New Silicon-nitride-bonded silicon carbide nozzle inserted into refractory lining

Advantages Gained Old ladle required replacement after 1 to 2 days service and control of pouring stream was difficult during latter part of run. With the new nozzle, runs of 1 to 2 weeks are possible and constant flow is maintained. In addition, the carbide nozzle is neither wet nor attacked by the molten metal.

Source: *Carborundum Co.*

Stillage Evaporator

Life expectancy doubled



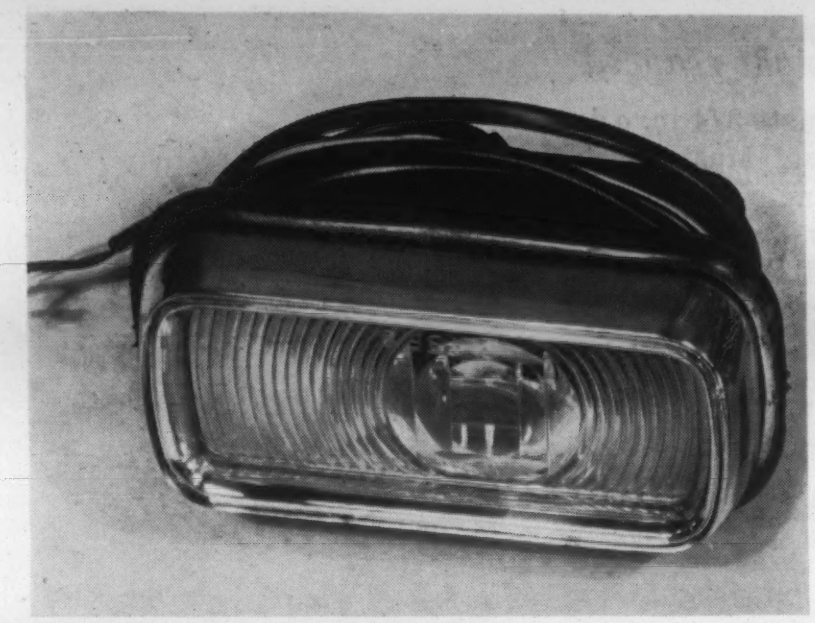
Must be corrosion resistant, operating in vapors at 212 F containing organic acids. Both inside and outside surfaces are subject to corrosive attack.

Old Copper tubing, 11 gage, 0.12 in. wall thickness.

New Welded stainless tubing, Type 304, with 0.065 in wall thickness.

Advantages Gained Doubled evaporator's life expectancy. Decrease in wall thickness increased tube capacity by 14%. Higher cost of stainless steel tubing compensated by doubled life expectancy.

Source: *Formed Steel Tube Institute.*



Parking Lamp Housing

Assembly simplified

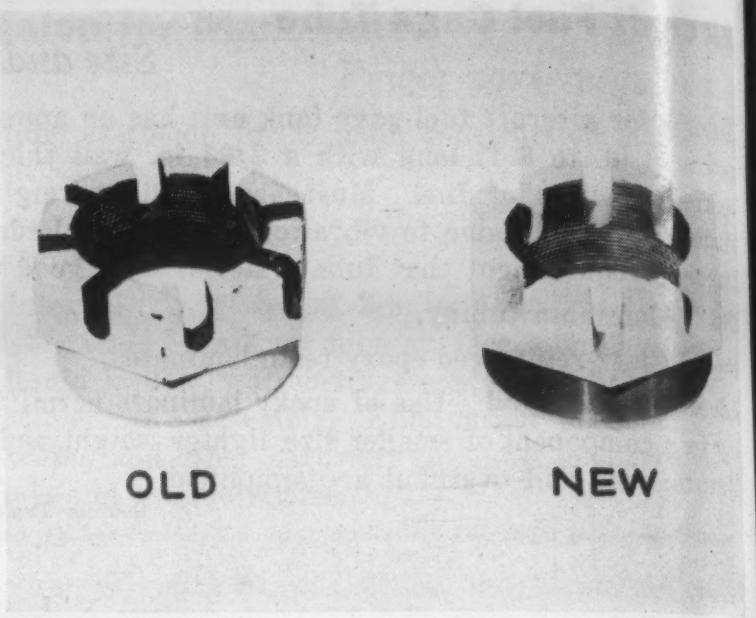
Must stand up under weather conditions and not stain body paints or plastics lenses. Provide shock proof mounting for bulb.

Old Zinc die casting.

New GR-S Rubber compound.

Advantages Gained Cost savings in material and assembly. Wiring is molded in place and lens is snapped into place without fasteners.

Source: *Chrysler Corp.*



Axle Nut

Production rate increased

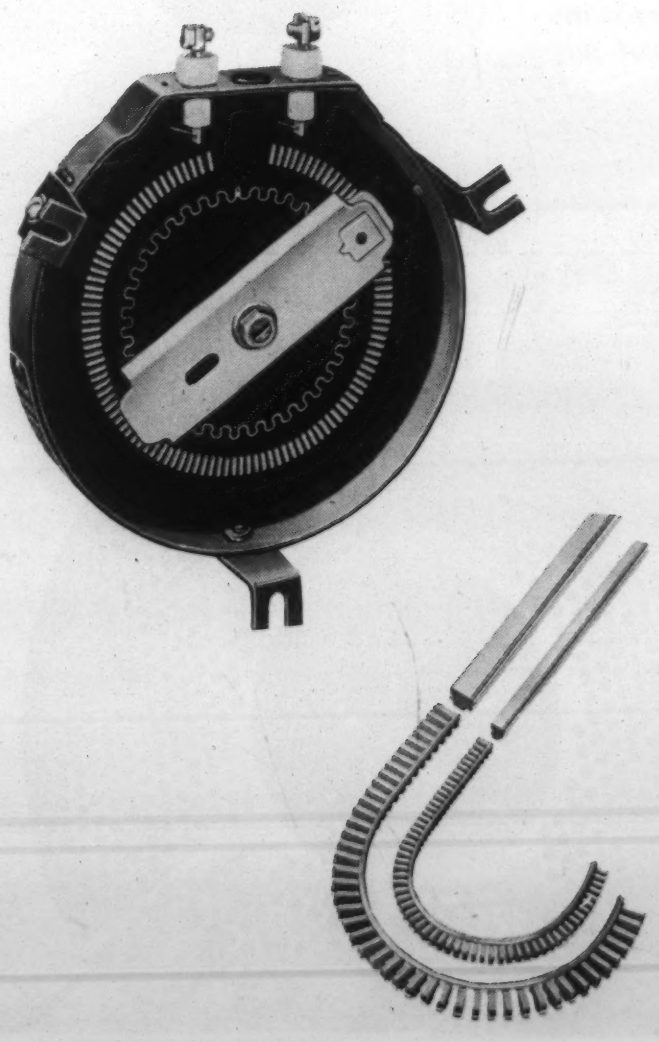
Nut and threads in i.d. must be strong enough to hold the rear wheel on a large scraper. Also holds grease seal and bearing in hub.

Old Steel forging (left).

New Pearlitic malleable iron casting (right).

Advantages Gained Cost of nut reduced 42% and production of pieces per hour increased 50%.

Source: *Caterpillar Tractor Co.*



Electrical Contacts for Rheostat

Improved performance

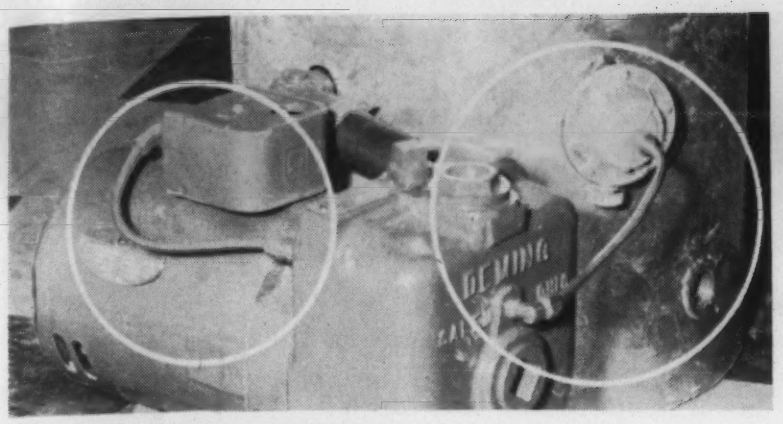
Shape is used for stationary contacts in Vitrohm rheostats of several sizes.

Old Contacts made from individual buttons blanked from sheet brass; buttons spaced manually on steel wire; assembly fired in vitreous enamel; steel wire milled off.

New Brass extruded shape is machine slotted into a series of buttons connected by a wire which is an integral part of the shape; part is fired in vitreous enamel; brass wire is milled off.

Advantages Gained More accurate spacing of contact improves performance of the rheostat, rejections are reduced, labor reduced approximately 50%.

Source: *Ward Leonard Electric Co.; American Brass Co.*



Air Lines for Pumps

Materials costs reduced

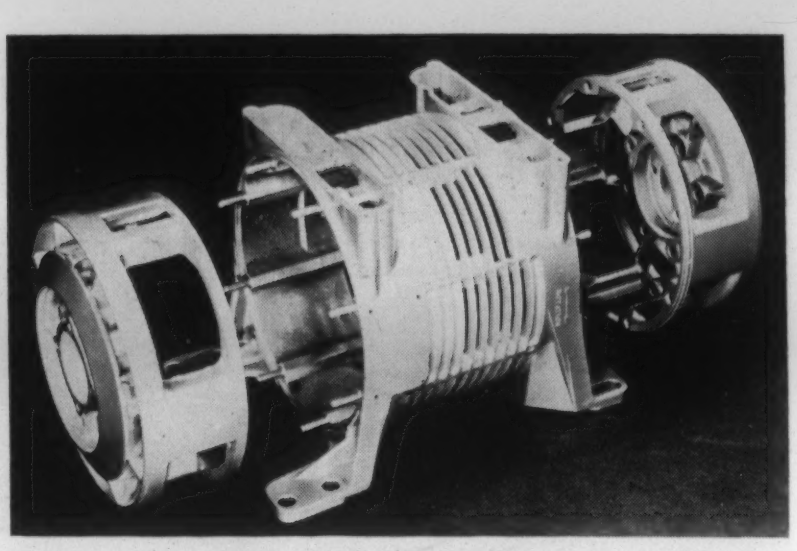
Used both as pressure switch and air control tubing on water system pumps, the ¼-in. o.d., 0.190-in. (i.d.) tubes must withstand continuous air pressure of 40 psi. Also they must resist vibrational fatigue, most chemicals, fungus, rot, rust, and rodents.

Old Copper tubing.

New Processed nylon pressure tubing with rated burst pressure of 1000 psi.

Advantages Gained Savings in materials cost amount to 40%. Installation time is also reduced. Nylon tubing has better resistance to impact and vibrational fatigue.

Source: *Polymer Corp.; Deming Co.*



Parts for Aircraft Inverter

One part replaced five

Housing (center) and end sections must be light in weight. Inverter must be cool running and require minimum maintenance.

Old Magnesium sand castings.

New Magnesium die casting.

Advantages Gained 54% cost reduction resulting from replacement of five sand castings by one die casting for housing and elimination of considerable machining.

Source: *American Die Casting Inst.*

Checking Fixture

Material cost saving

Checking fixture for aircraft parts must be free from warpage in sawing and boring of holes. Flatness must be readily achieved.

Old Cast and machined aluminum plate.

New Magnesium tooling plate, ½ in. thick.

Advantages Gained In purchasing 31 pieces of the new material, a net saving of $1045 was realized. The maximum flatness deviation for plate of this thickness (0.005 in. per ft) is excellent. The magnesium tooling plate was anneal flattened at the mill, and no machining of the surface was necessary.

Source: *Dow Chemical Co., American Society of Tool Engineers*

Dome Lid for Truck Trailer

Keeps moisture from cargo

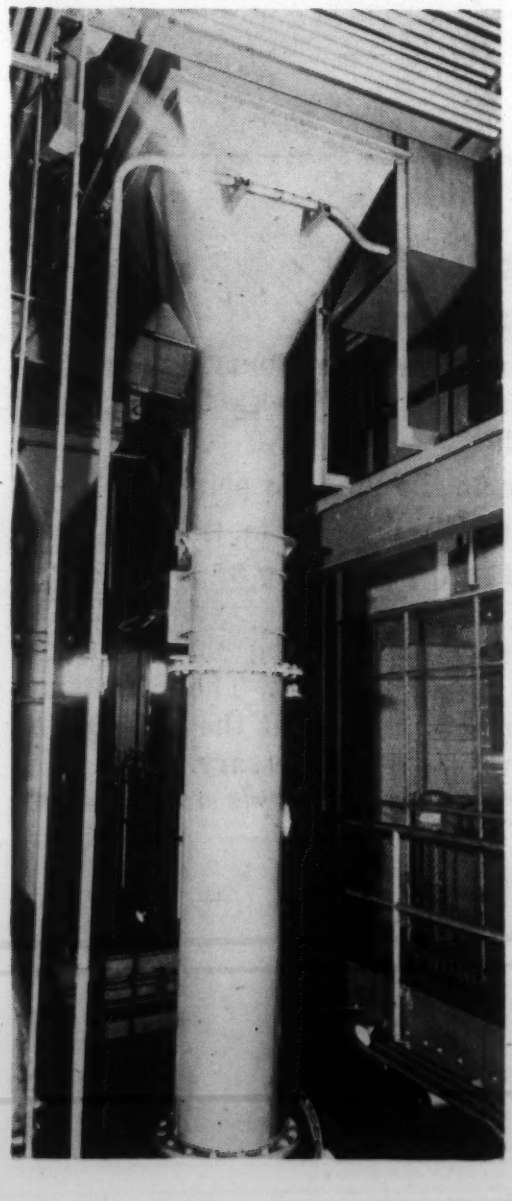
Dome lids for truck trailers designed to haul dry cement. Must be rugged and must prevent moisture of any kind from reaching cargo. Also must prevent leakage of cargo from trailer.

Old Riveted aluminum sheet.

New Glass-reinforced polyester laminate.

Advantages Gained Condensation moisture will not form on the plastic. Molded in one piece, lids weigh only 150 lb, and will not shatter, corrode or warp; thus maintenance costs are reduced.

Source: *Naugatuck Chemical Div., U. S. Rubber Co.*



← Coal Handling Equipment

Reduced maintenance and replacement costs

Equipment must withstand severe abrasive action of sliding coal and resistance to corrosion from water and sulfur in the coal.

Old Carbon steel, 0.562 in.

New Stainless clad steel, 0.25 in.

Advantages Gained Over a 15-yr period savings totaled $35,980. This was due largely to reduced maintenance and replacement costs. No loss of gage has been detected in the stainless clad steel.

Source: *Lukens Steel Co.*

Valve for Neutralizing Unit →

Corrosion resistance increased

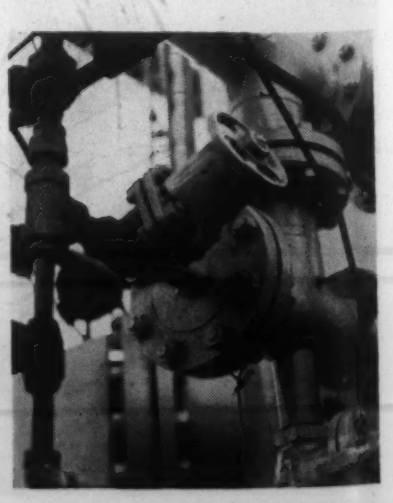
Service in petroleum refinery involves exposure to sulfuric acid on one side and live steam on other.

Old Steel.

New Nickel alloy (Hastelloy B).

Advantages Gained Steel valve was detroyed in one day, nickel alloy valve lasts indefinitely.

Source: *Haynes Stellite Co.*



Dial Pointer for Antenna Rotator

Lower scrap rate

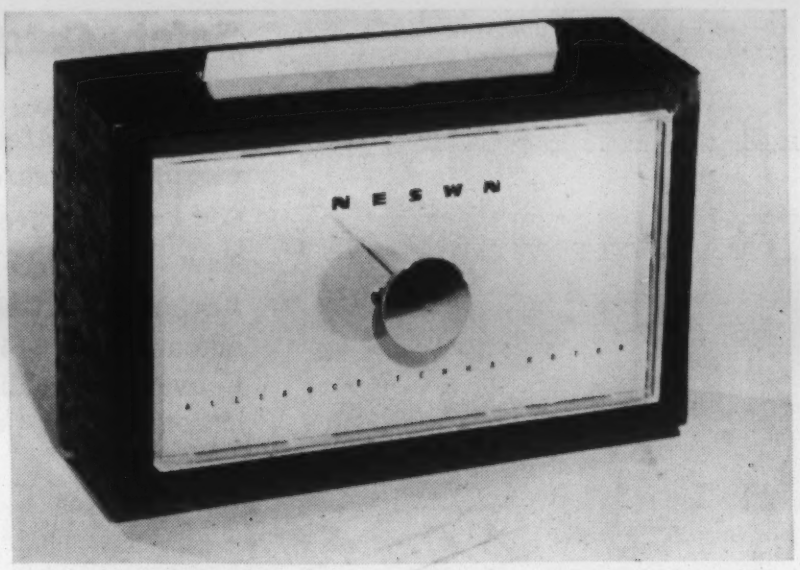
Dial pointer on control for rotating TV antenna. Thin angle section 1½ in. long, measuring 3/32 in. wide and 1/16 in. high.

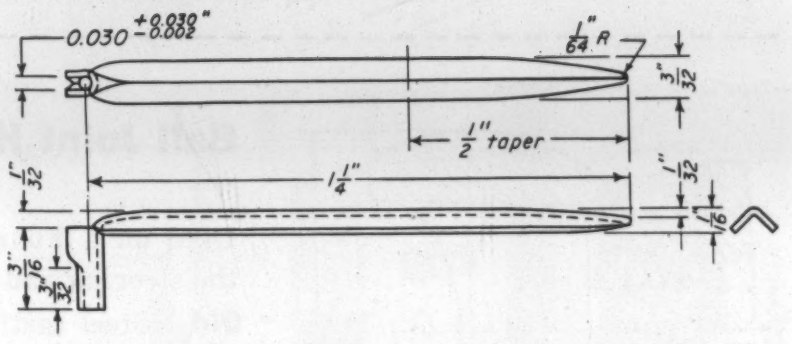
Old Stamped from No. 30 B&S gage aluminum 1100-H12 sheet. Sheet purchased in 12 in. width, anodized and colored, sheared to 3/8 in. width, then stamped.

New Stamped from No. 30 B&S gage, continuously anodized, brass-colored aluminum 1100-H12 coil strip. Strip purchased in coils $3/8 \frac{+0}{-1/32}$ in. wide.

Advantages Gained Lower cost due to much lower scrap rate. Old material had to be purchased in large width for handling during anodizing. High scrap with old material was due to 1) bending and wrinkling of thin sheet during anodizing, and 2) inability to shear thin sheet accurately, with result that finished pieces were either undersize or would lock in die.

Source: *Alliance Mfg. Co.; Fromson Orban Co., Inc.*





Insulation for Armature Coil

Better fit achieved

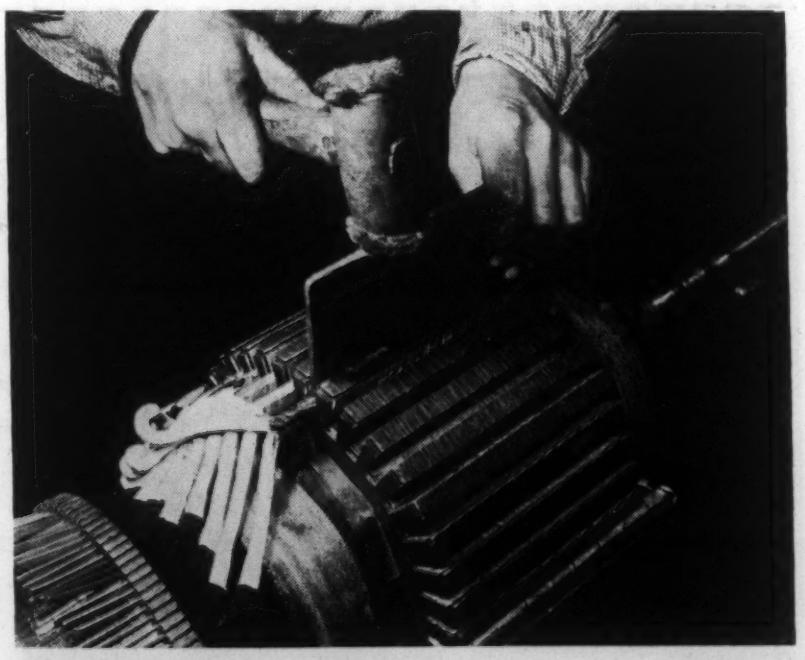
Electrically insulating sheet material for wrapping armature coils.

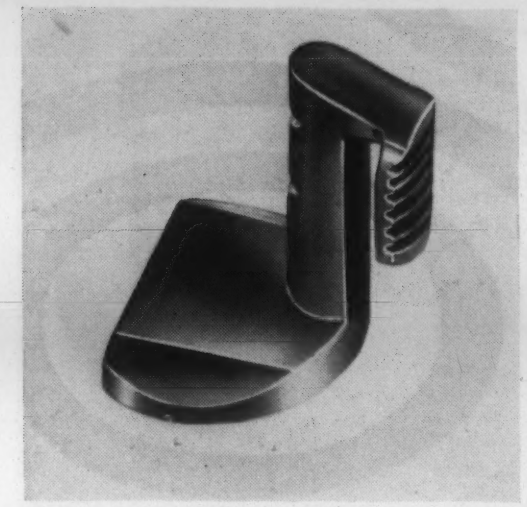
Old Overlapping mica flakes glued or cemented to a paper or cloth backing.

New Flexible sheet material consisting of two sheets of high-purity asbestos paper saturated with polyvinyl acetate resin and calendered together under heat and pressure.

Advantages Gained Since thickness tolerances on the new material are much smaller than on the old, coils have more accurate dimensions and fit armature better. Unlike mica, which has a high spring-back tendency, the asbestos material conforms readily to the shape of the coil and does not tend to pull away from the coil after a period of time. Asbestos laminate also has less tendency to crack or split, and is smoother and more pleasant to handle.

Source: *Johns-Manville*





Safety Catch for Rifle

Large saving

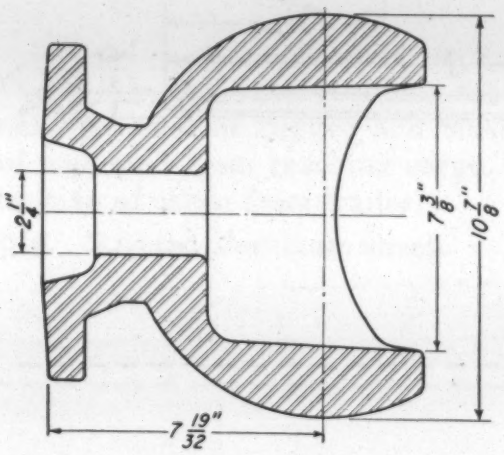
Automatic safety catch for gas power target rifles. Part precision essential for safety feature.

Old Three piece assembly.

New One piece die casting.

Advantages Gained An overall saving of 86%; assembled piece amounted to $14.30 per hundred, die cast piece to $16.50 per thousand. Conversion to die casting eliminated the possibility of assembled parts loosening and provided more consistent production.

Source: *Gries Reproducer Corp.*



Ball Joint Housing

Service failures eliminated

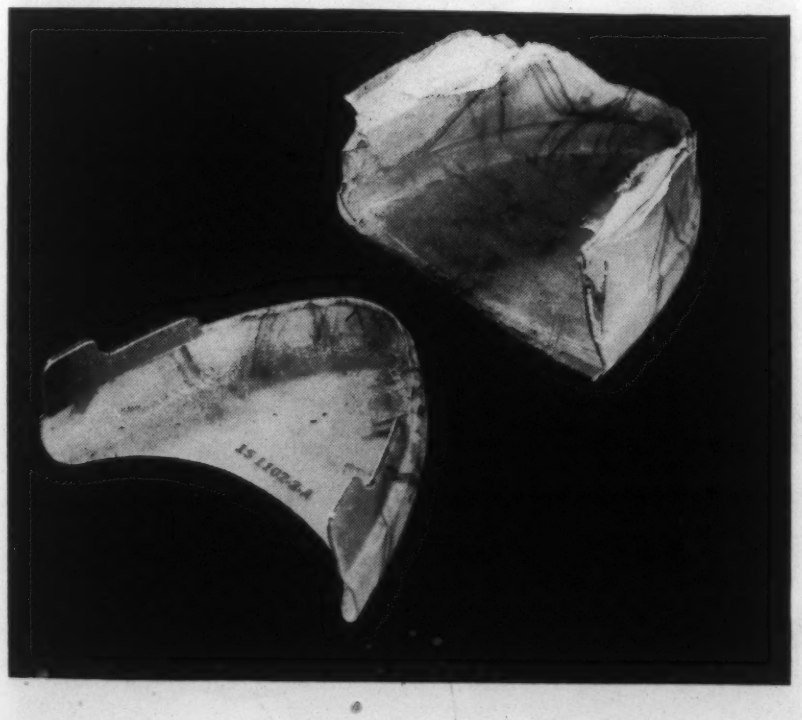
Used on a Four Wheel Drive End Loader as a ball joint housing for the steering and driving mechanism.

Old Steel casting.

New Upset steel forging.

Advantages Gained Initial cost savings, 90¢ per part, machining costs reduced approximately 15%. Service failures, a serious problem with castings, no longer occur.

Source: *Commercial Shearing & Stamping Co.; Clark Equipment Co.*



Propeller Cuff Cover Plate

Fatigue resistance improved

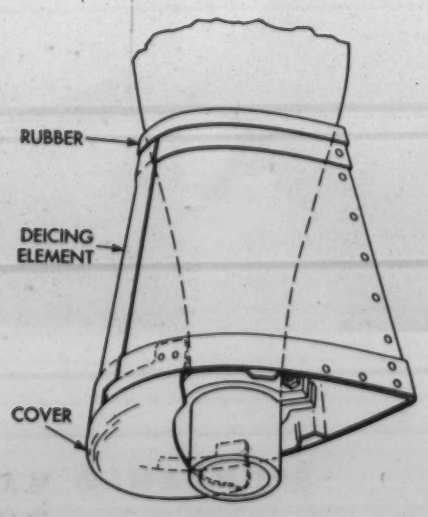
Cuff cover plates are fitted to the inboard end of the propeller cuff to reduce wind resistance and turbulence. They must be light weight and resistant to fatigue.

Old Sheet aluminum, 1/16 in. thick, reinforced with aluminum doublers at mounting edges.

New Glass-reinforced epoxy laminate.

Advantages Gained After long service under severe vibration aluminum plates cracked at point of attachment to propeller cuff. After 1000 hr flight time, no plastic plate has cracked. New part is lighter and thickness of laminate can be altered where necessary; 14 layers of resin-impregnated cloth provide high strength and rigidity at point of attachment, while 6 layers in web area provide the greater flexibility required.

Source: *Shell Chemical Corp.; Propeller Div., Curtiss-Wright Corp.*



Tub for Commercial Dish Washing Machine

Improved corrosion resistance

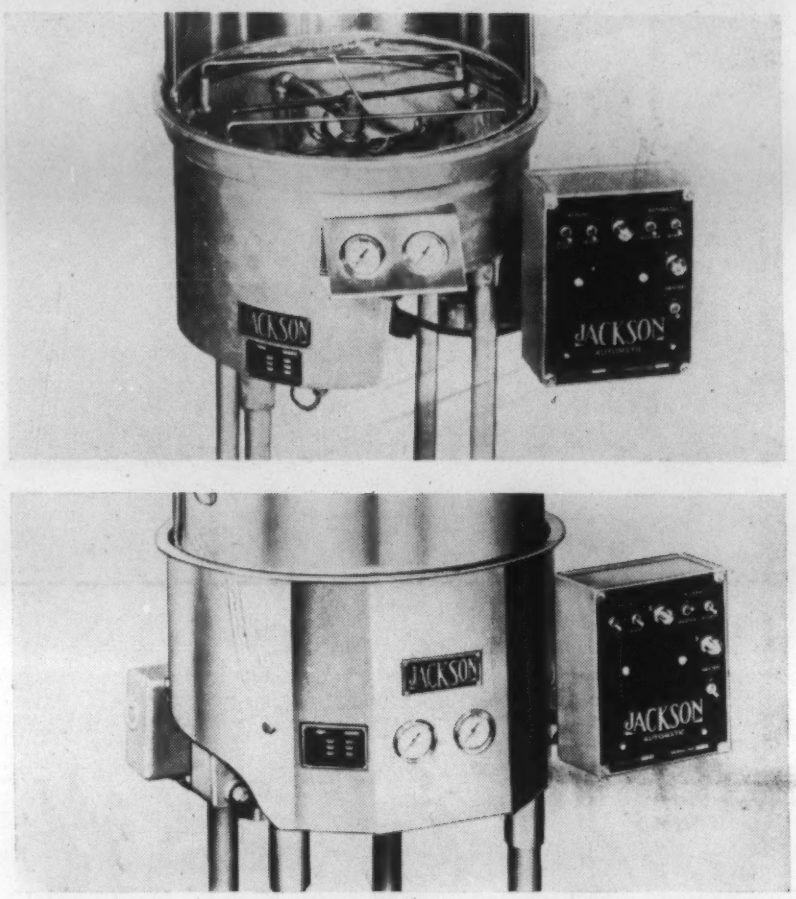
Part must withstand the corrosive effects of food residues and harsh detergents. Unit is designed to wash 950 dishes per hr. Wash cycle consists of 60 sec with detergent solution at 80 gal per min followed by 10 sec rinse with water at 180 F.

Old Aluminum casting (top).

New Type 304 stainless steel 16 gage sheet, deep drawn in a single operation (bottom).

Advantages Gained Weight of part reduced from 54 to 42 lb. No longer necessary to specify detergent. Previously this practice was followed since many of the strong commercial detergents pitted the cast aluminum. Service life was increased also.

Source: *Committee of Stainless Steel Producers, AISI*



Cutter Bar for Mower

Breakage eliminated

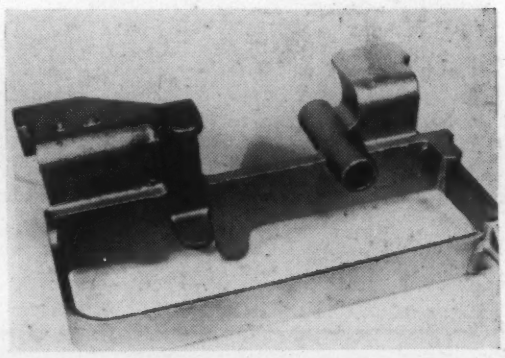
Cutter bar and coulter shaft frame supports mower projecting from side of tractor. Must withstand shocks and lashing action.

Old Fabricated from 15 pieces of bar stock.

New Single steel casting.

Advantages Gained Reduced overall cost 53% and eliminated service costs due to parts breakage prevalent in the former assembly. Casting also gives accurate alignment, greater strength and simplifies inventory and parts problems.

Source: *Steel Founders' Society of America*



Automobile Grille Insert

Plating eliminated

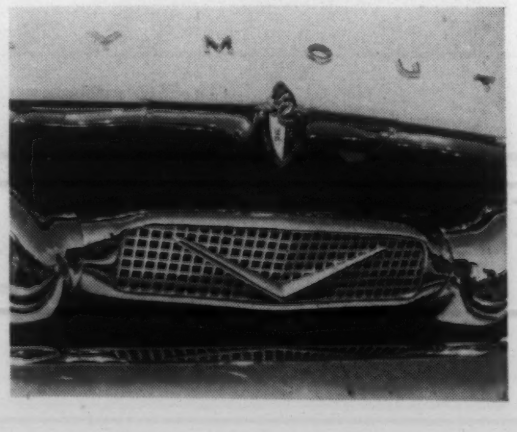
Service requires good resistance to corrosion and to abrasion from sand or small stones. Fabrication requirements are ease of perforating and stamping and low cost finishing.

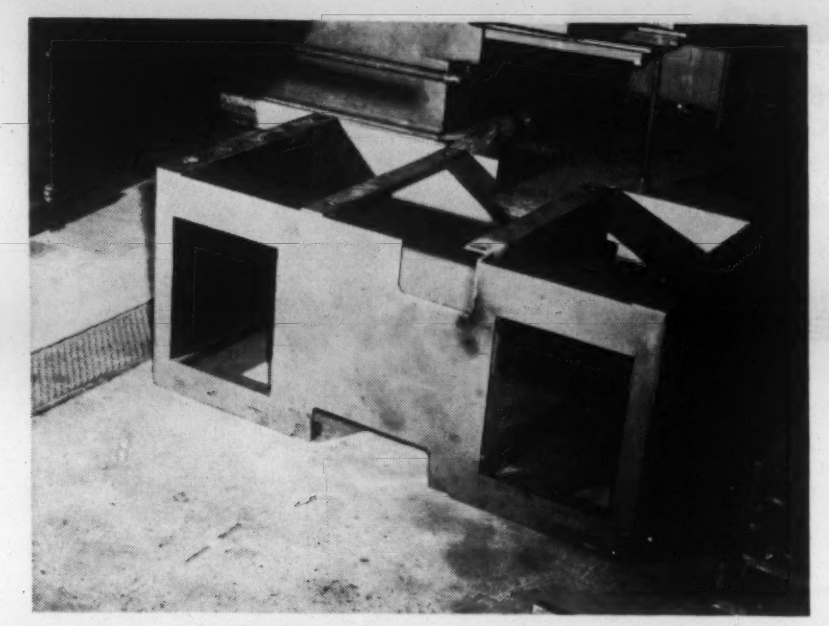
Old Cold rolled low carbon steel, nickel-chromium plated.

New Aluminum alloy 3003, anodized.

Advantages Gained Anodizing was not handicapped by the perforated design in the same manner as was plating. Anodized surface gives better performance than nickel-chromium plated surface.

Source: *Chrysler Corp.*





Machine Base

Weight and cost reduced

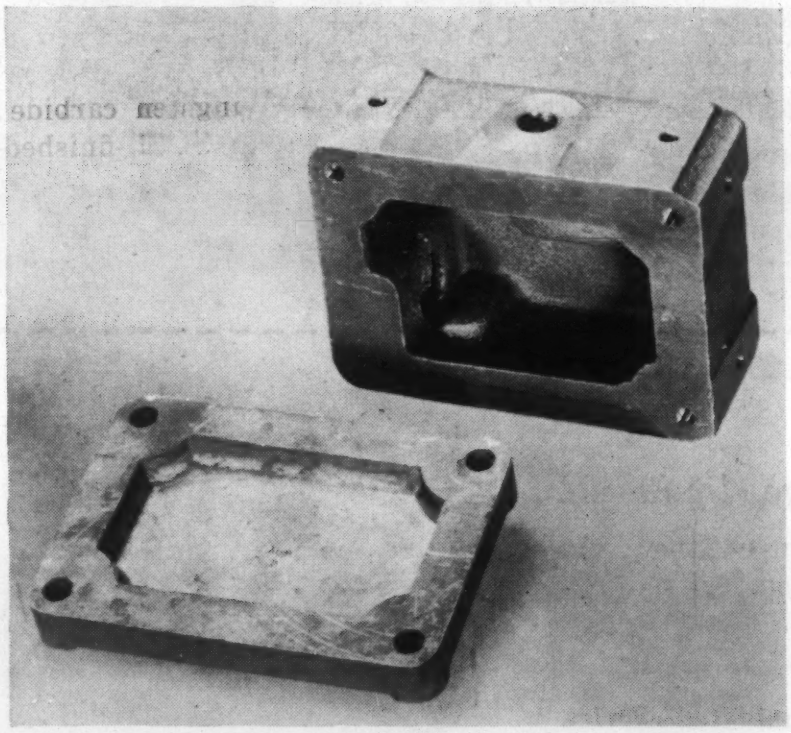
Machine base (64 x 40 x 34) for drilling, reaming and boring machine.

Old Cast iron, two pedestals.

New Steel sheet formed to make three sides with plate welded at two corners to make fourth side.

Advantages Gained Over 50% cost saving and 40% reduction in weight. Under deflection test, tolerances with cast base were 0.017, with weldment 0.002—an eight fold advantage. Weldment is more easily shipped.

Source: *Lincoln Electric Co.*



Switch Housing and Cover

Corrosion resistance increased

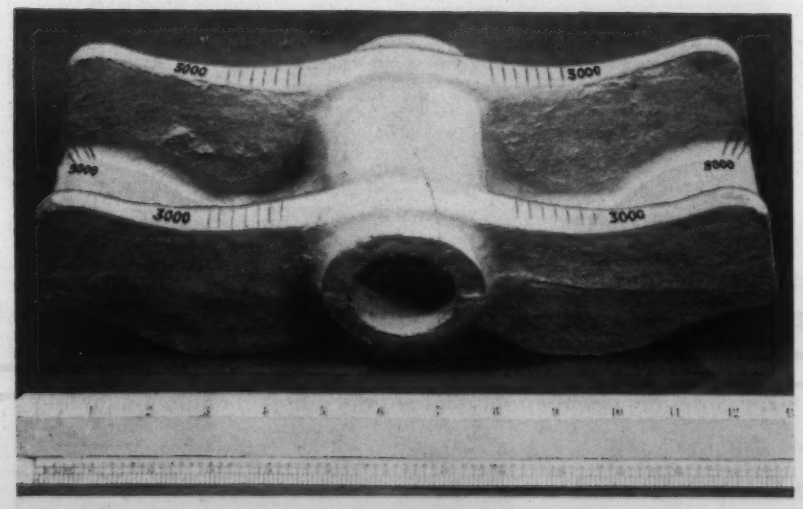
Switch housings must withstand any explosion that might occur within its walls. Close tolerance dimensions must be maintained.

Old Sand-cast iron.

New Die-cast aluminum.

Advantages Gained Much lighter parts resulted in reduced shipping costs. Fewer rejects and the elimination of lacquering housing interior to inhibit corrosion also reduced costs. Product had more attractive appearance.

Sources: *Micro Switch, Minneapolis-Honeywell Regulator Co.*



Spring Equalizer in Suspension Unit

Stress load lowered

Functions as retainer and equalizer in spring suspension unit of a tandem trailer. Subject to total load of 20,000 lb.

Old Fabricated of rolled plate and tube stock.

New Steel casting.

Advantages Gained Maximum stress load at any point reduced to 3000 psi as contrasted with original part which had areas of high stress in the range of 17,000 psi. About 300% increase in strength and a 5 lb reduction in weight for each stabilizer. In addition casting eliminated service failures and customer final assembly problems.

Source: *Steel Founders' Society of America*

Anode Bag for Precious Metal Filtration

Maintenance virtually eliminated

Fiber anode bag used for liquid filtration (collection of solids) in electrolytic refining of precious metals. Bag must be strong and resist abrasion, flexing, heat, chemicals, escape of solids and blinding or plugging. Must also provide adequate flow rates and easy removal of filter cake.

Old Wool or acrylic fiber.

New Tetrafluoroethylene fiber (Teflon).

Advantages Gained Tetrafluoroethylene bag lasts 80 wk, compared with 4 wk for acrylic fiber and 2 or 3 days for wool. New bag costs 8 times as much as acrylic but lasts 20 times as long, resulting in an economic ratio (exclusive of maintenance and replacement expenses) of 1 to 2.5 in favor of Teflon.

Source: *E. I. du Pont de Nemours & Co., Inc.*

Sockets for Grill

Welding speed increased

Parts are used in the assembly of an outdoor grill.

Old Steel screw machine parts. Large socket is 1 in. dia by 1⅜ in. long and smaller socket ⅝ in. dia by 1 in. long.

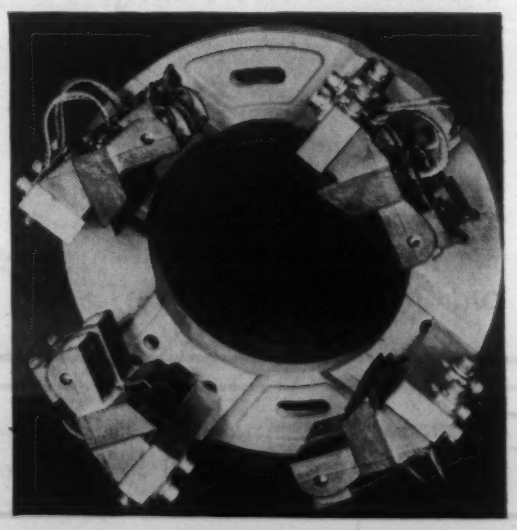
New Iron powder part infiltrated with copper.

Advantages Gained New parts could be spot welded to rest of assembly at a considerable increase in production rate over the arc welding procedure used previously. Converting to the metal powder product saved 25% of cost on large socket and 50% on the smaller one.

Source: *Beemer Engineering Co.*

Rocker-Ring for Motor Brushes

Machining, assembly reduced



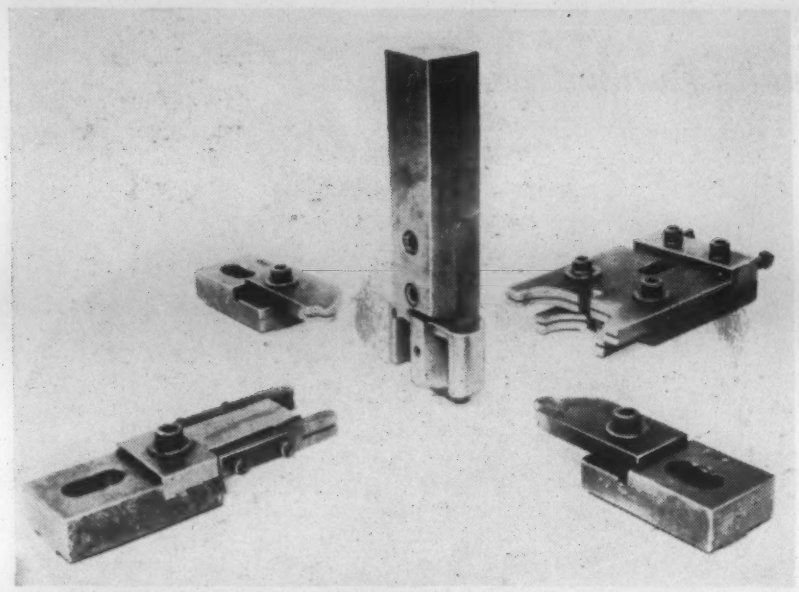
Supports brush rigging in industrial d.c. motors ranging from 1 to 50 h.p. Must be stable and rugged enough to maintain accurate alignment of brush rigging when subjected to vibration and elevated temperatures. Measures 6-15 in. o.d.

Old Malleable cast iron, finish machined to achieve sufficient planity and close tolerances. Brush studs, joined separately to rocker, utilized Class A insulating sleeves and washers.

New Rocker and studs molded in one piece from glass fiber reinforced polyester premix molding compound.

Advantages Gained Final machining eliminated. Separately insulated and assembled brush studs eliminated. Entire assembly rated Class B. Parts inventory reduced.

Source: *Glastic Corp.*



Wire Forming Mandrels

Longer wear life

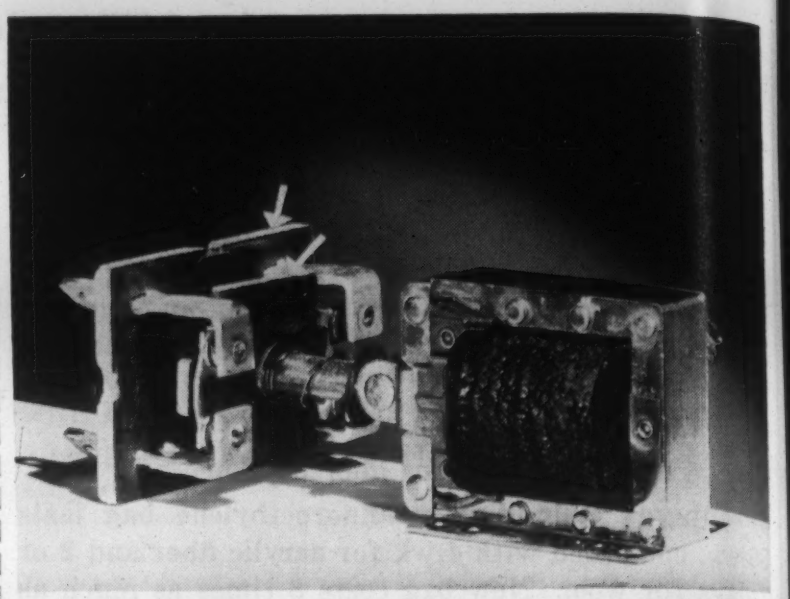
Tools that slide in horizontal plane to form wire springs or clips around a vertical mandrel.

Old Hardened tool steel, unprotected.

New Hardened tool steel "Flame-Plated" with thin, hard tungsten carbide coating. Coating on vertical mandrel brush-finished to provide smooth surface.

Advantages Gained Greater wear resistance has increased tool life ten times, also made it possible to increase production of machine from the normal 45 pieces per min to 78 pieces per min.

Source: *Linde Air Products Co.*



Contact Mounting Plate for Solenoid

Increased capacity

Contact mounting plate and base plate for solenoid switch used in home laundry dryers, battery chargers, heating elements, etc. Must provide good insulation over long periods of time when exposed to heat and high humidity.

Old Canvas-reinforced phenolic high-pressure-laminated sheet, cut and punched.

New Glass fiber-reinforced polyester laminated sheet 1/8 in. thick, cut and punched.

Advantages Gained Previously, switch capacity was limited to 25 amp a.c. Plates tended to warp and shrink at elevated operating temperatures, causing misalignment of contact points and consequent arcing and burn-out. Higher heat resistance of new plates has eliminated distortion and made it possible to increase switch capacity to 50 amp d.c. Arc resistance also raised from 5 sec to 120 sec.

Source: *Glastic Corp.*

Power Plant Pump Plungers

Increased wear resistance

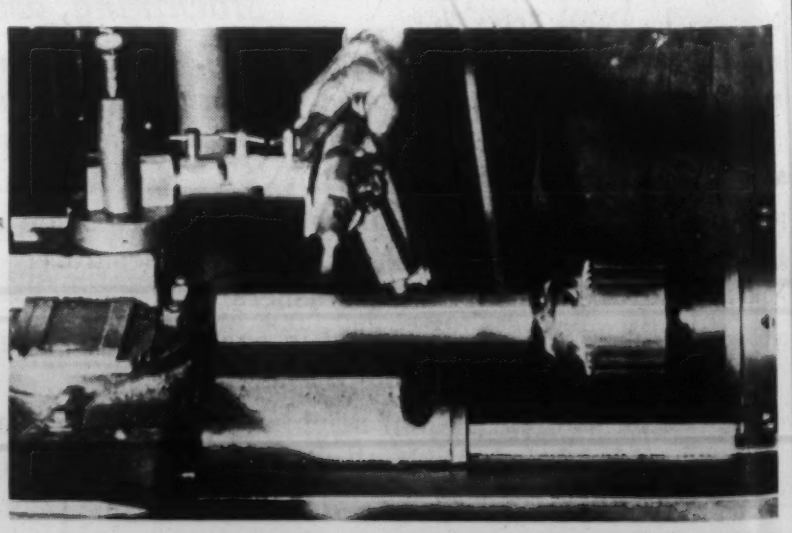
These pumps are used in the power plant of a steel company and handle water which contains grit and other foreign substances. Plungers require protection against abrasion. Close dimensional tolerances must be maintained to insure tight fits.

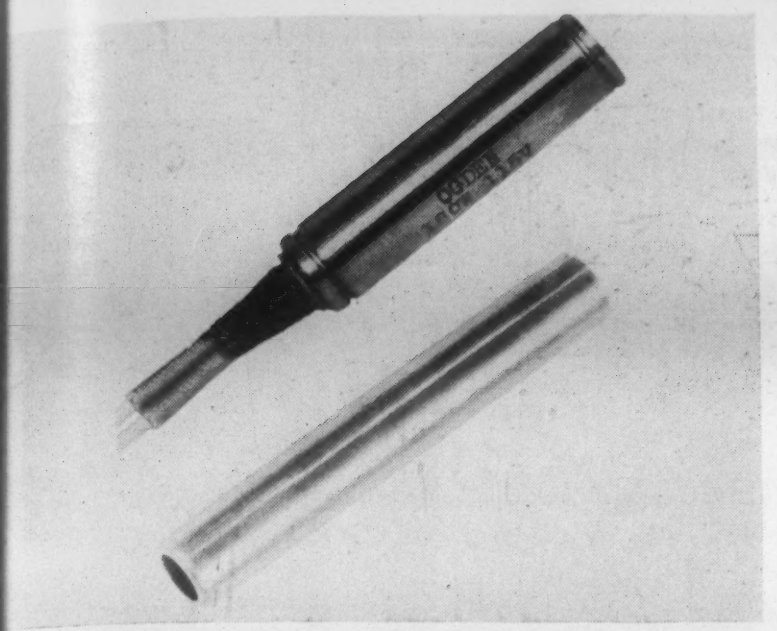
Old Chromium-plated steel.

New Hard-faced with nickel-base chromium boron alloy.

Advantages Gained Service life for the new part 10 mo compared with 6 to 8 wk for chromium plated parts. Cost of surfacing approximately the same as plating but maintenance costs and downtime reduced 600%.

Source: *Wall Colmonoy Corp.*





Sheaths for Cartridge Heating Units

Binding reduced

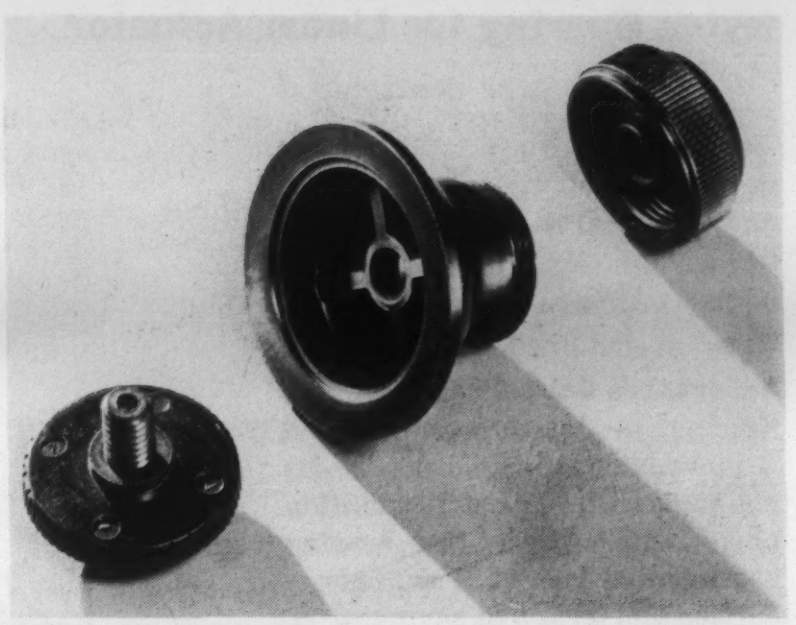
Sheaths must fit snugly but must not bind even when current is passing. Must have good thermal conductivity to minimize heat loss, must resist denting in use even though wall is only 0.022 in. thick.

Old Brass tubing.

New Tubing of Cupro-nickel, 30%.

Advantages Gained The new material reduced tendency to bind because of lower thermal expansion than the brass, but had thermal conductivity as good as brass. New material has greater resistance to denting in service.

Source: *Ogden Mfg. Co.; Superior Tube Co.*



Nozzles for Commercial Dishwasher

Unit costs reduced

Part must be economical to produce, durable, and provide resistance to corrosion, distortion and softening.

Old Stainless steel.

New Flock-filled, black phenolic.

Advantages Gained Cost of part has been lowered without any sacrifice in durability and corrosion resistance. Phenolic nozzle does not distort or soften in extremely hot water.

Source: *Hooker Electrochemical Co.*

Blowout Support in Circuit Breaker

Assembly cost eliminated

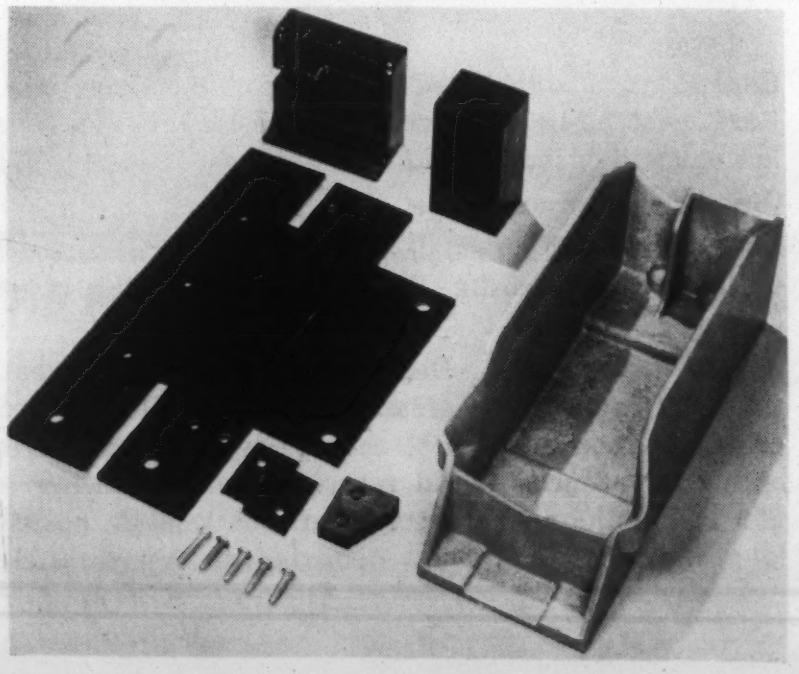
Rear blowout part that supports and insulates arc chute assembly in a 5 kv air-type circuit breaker. Must withstand heat and flame, as well as mechanical shock resulting from opening and closing of heavy circuit breaker contacts. About 15 x 6 x 6 in.

Old Mechanically fastened assembly of seven pieces machined from canvas-reinforced phenolic sheet or molded of a general purpose phenolic compound (left).

New Glass fiber-reinforced polyester premix compound molded to close tolerances (right).

Advantages Gained Assembly, machining and separate molding operations eliminated. Parts inventory reduced. Total savings 60% for each part.

Source: *Glastic Corp.*



Nylon Bearing for Linear Actuator

Maintenance minimized

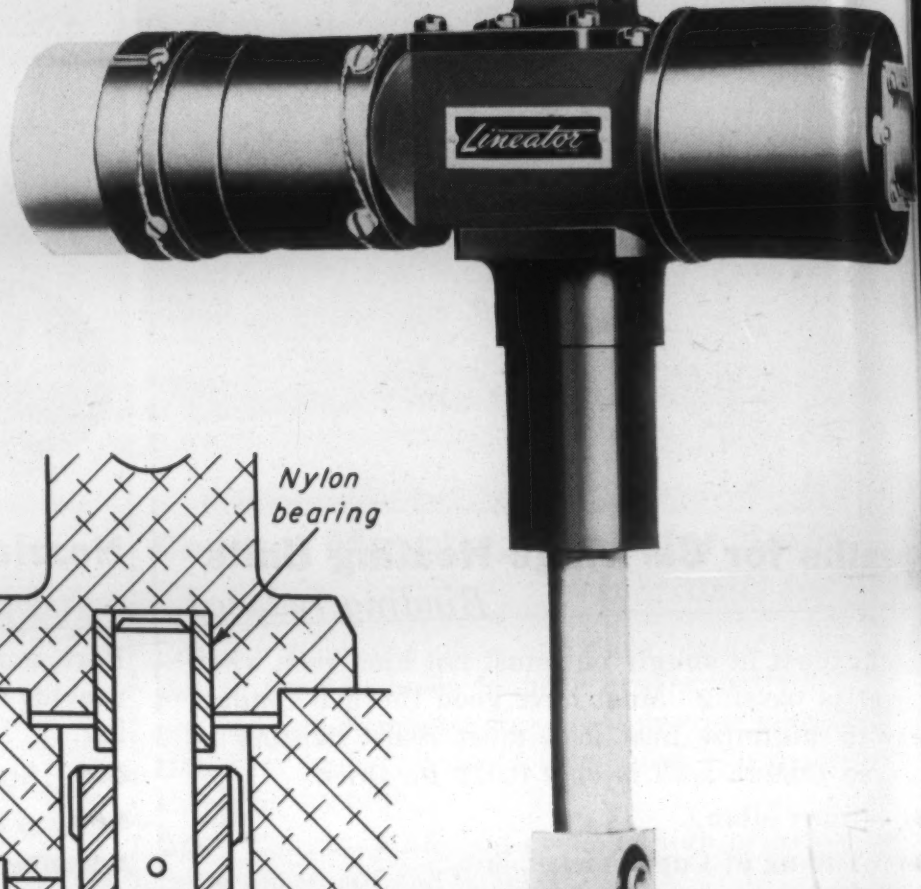
Bearing used in aircraft linear actuator must be compact, light and trouble-free.

Old Plain metallic sleeve bearing or ball bearing.

New Nylon lined bearing.

Advantages Gained Operation of bearing in inaccessible location without lubrication solved serious maintenance problem. In addition to its smaller size, the bearing has resulted in a 75% weight reduction and 50% cost savings over equivalent capacity ball bearings. Other cited advantages include superior corrosion resistance and freedom from brinelling during vibration.

Sources: *Thomson Industries, Inc.; Airborne Accessories Corp.*



Cone for High Speed Clutch

Moment of inertia lowered

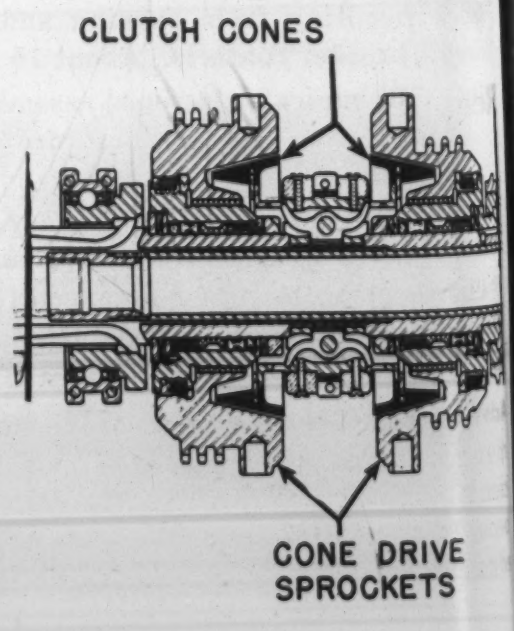
Cone used in high speed reversing clutch in automatic screw machine. Part must be light in weight, have high strength-to-weight ratio, plus low moment of inertia and good heat resistance.

Old Cast iron or bronze.

New Molded from small flakes of macerated cotton fabric impregnated with a phenolic resin. Steel engagement ring is molded directly into cone.

Advantages Gained Decreased weight and moment of inertia cut the time lost in clutch reversals. Reversing clutch connects the spindle to a constant-speed drive in ½ sec and is operated at frequencies as fast as once every 3 sec. Rapid reversals send operating temperatures up to 250 F, yet the phenolic cone provides smooth, positive clutch action, is long wearing, and is not distorted or deteriorated by the high heat.

Sources: *Synthane Corp.; Brown & Sharpe Manufacturing Co.*



Terminals on Seismograph

Moisture trouble eliminated

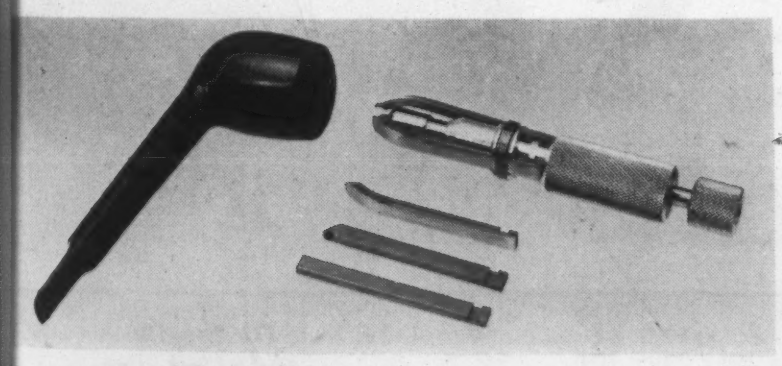
Terminals, plug strips and other exposed connections in seismographs used by oil exploration teams.

Old Copper, lead-tin and aluminum.

New Same plus thin sprayed coating of dimethyl silicone fluid.

Advantages Gained Previously, moisture condensation often made it necessary to dry and clean instrument before it could be operated. Coating has virtually eliminated moisture condensation difficulties and has reduced maintenance.

Source: *Dow Corning Corp.*



Reamer Blades

Cutting efficiency improved

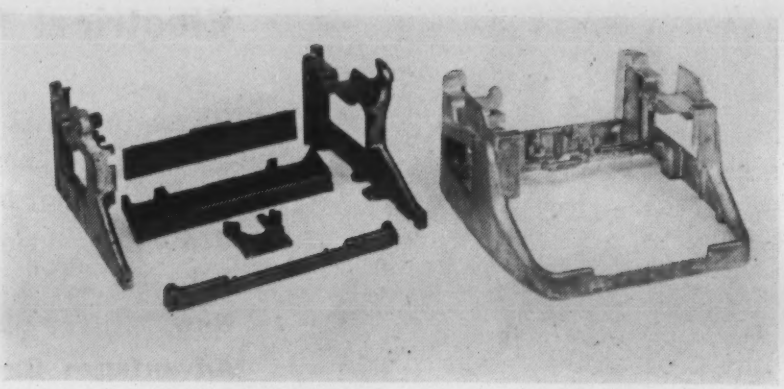
Blades are expanded inside a pipe and rotated to remove excess coke and a sharp cutting edge is required.

Old Chromium plated steel.

New Stainless steel Type 416.

Advantages Gained With old procedure, plating rounded edges of blades and reduced cutting efficiency, one out of every three blades was rejected because of poor plating. Stainless blades hold a sharp edge and rejections were eliminated.

Source: *Carpenter Steel Co.*



Typewriter Frame

One part replaced six

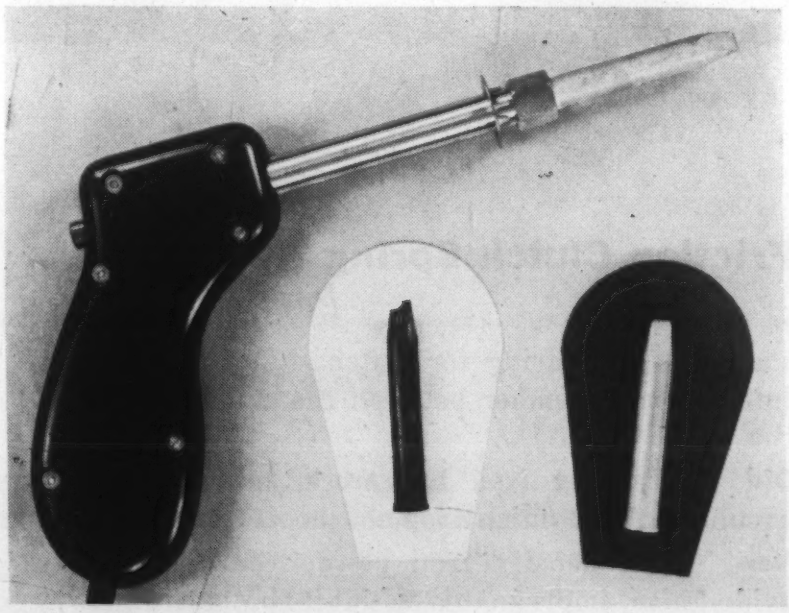
The frame must be strong, rigid and light in weight.

Old Iron sand castings (left).

New Aluminum die casting (right).

Advantages Gained A one-piece aluminum die casting replaced six iron sand castings with a reduction in weight of 5½ lb. Machining and drilling eliminated. No assembly required which eliminated requirement for fasteners.

Source: *American Die Casting Inst.*



Tip for Soldering Gun

Life increased

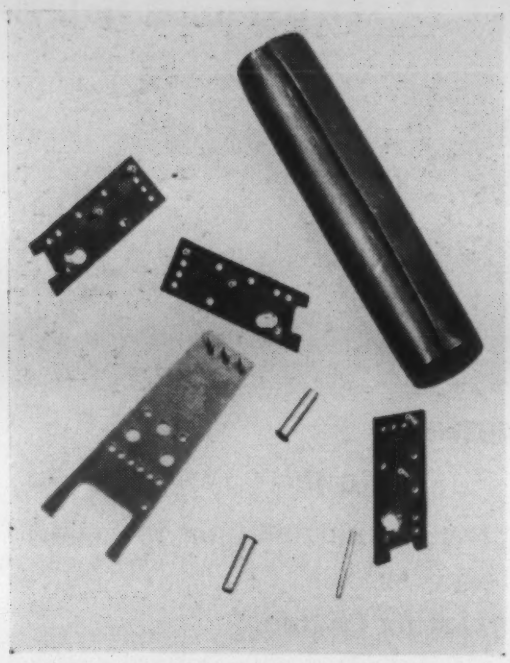
Constant high temperature soldering tip for production line soldering in electronic and electrical industries.

Old Leaded (0.5%) copper (left).

New Same protected with 5-mil iron electroplate (right).

Advantages Gained About 10 times longer life. Life of soldering tips operating at high temperature is governed by rate at which copper dissolves in the tin of the solder. Electrolytic iron coating puts barrier between copper and tin.

Sources: *Vari Corp.; Van der Horst Corp. of America*



Electrical Terminal Posts

Reduction in scrap losses

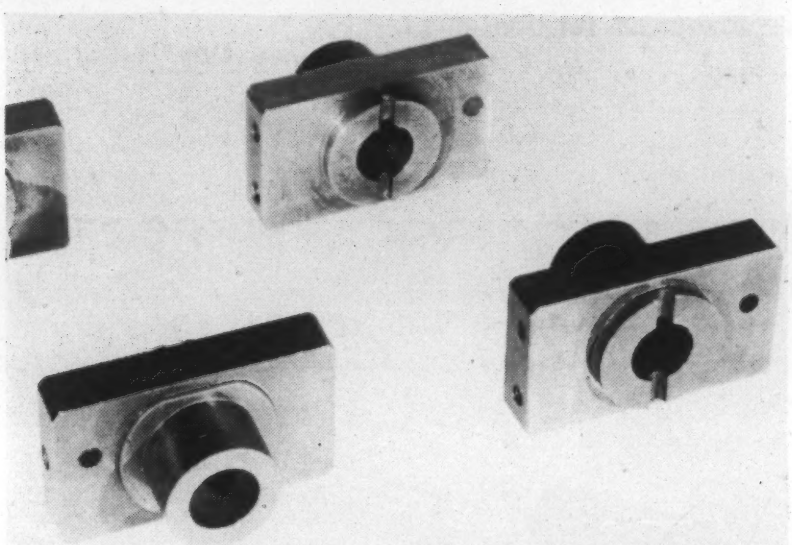
These terminal posts are used for attaching electrical leads in a hearing aid device. They must fit tightly in thin plastic insulating strips where eyelets cannot be used because there is insufficient space between holes.

Old Conventional pins made on screw machine (composition not known).

New Silver plated beryllium-copper Spirol pins.

Advantages Gained The new pins consist of a strip of coiled metal which holds itself in place by the spring action of the spiral. With the previous solid pins, tolerances were critical since slightly oversize pins or undersize holes caused cracking of the plastic. The new pins permitted greater variation in hole size since the spring action of the spiral insures complete tightness.

Source: *Talbot Associates, Inc.*



Friction Clutch Spring Hub

Part cost reduced

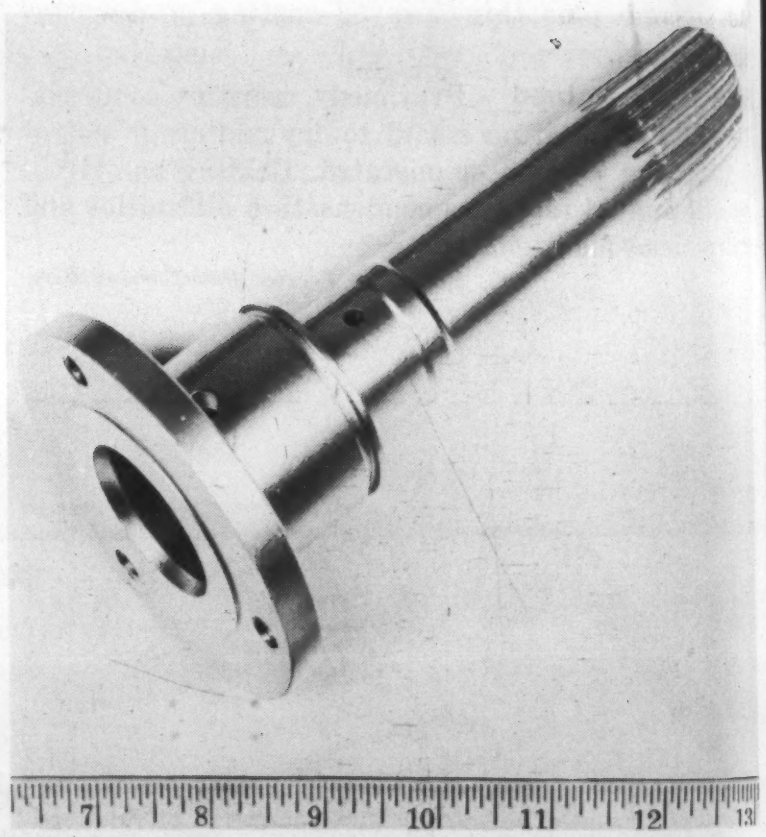
Part acts as bearing for clutch shaft as well as the intermediate member between the clutch spring and the clutch shaft.

Old Cast gray iron bar stock, bearing surfaces ground to V-32 finish (top).

New High density iron powder part with black oxide finish, impregnated with oil (bottom).

Advantages Gained Previous part cost: $1.50 each. New cost: $0.24 each. (Tool cost: $1600) By changing to powdered metal the following manufacturing operations were eliminated: turning, drilling, boring, milling and grinding.

Source: *International Business Machines Corp.*



Torque Converter Reaction Shaft

Production rate increased

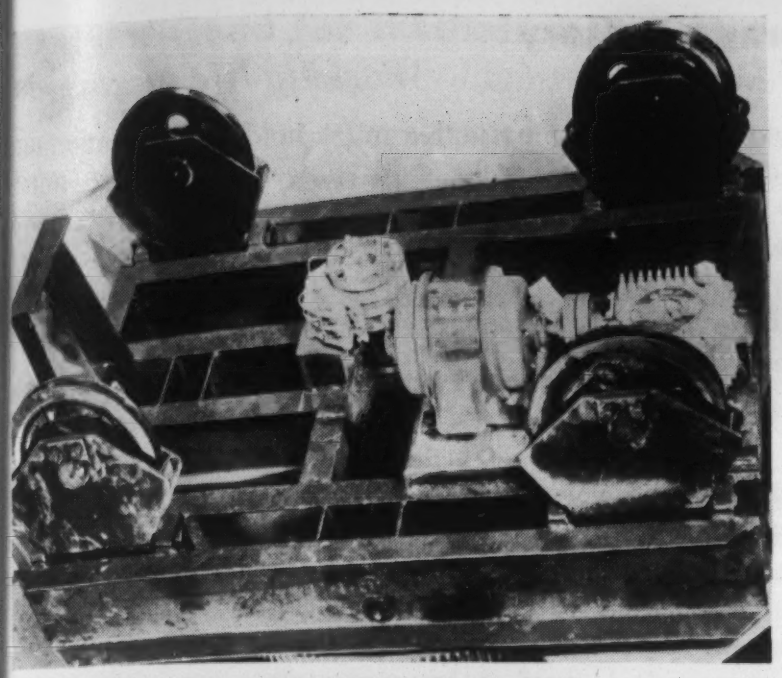
Shaft must transmit high torque load. It is hollow having one end flanged and the other end splined.

Old AISI 1141 steel, forged and machined.

New Aluminum AA6061, cold impact extruded and machined.

Advantages Gained Substantial cost savings obtained by use of impact extrusion, a high production process, which produces a shape very close to final requirements with a minimum of machining operations.

Source: *Chrysler Corp.*



Sheaves for Overhead Crane

Wear life increased

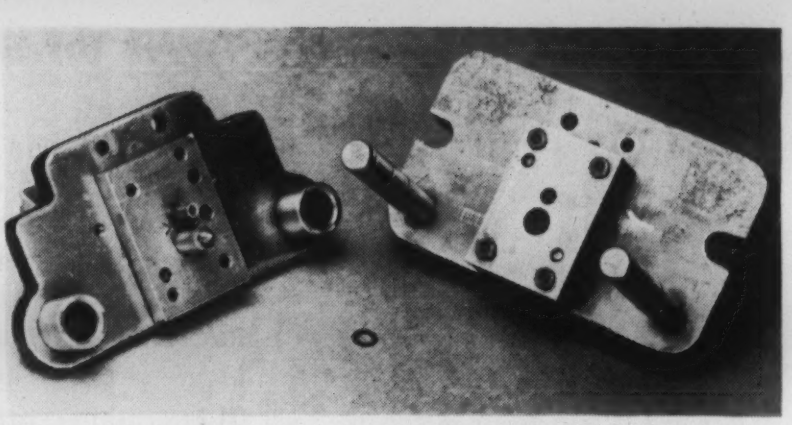
These sheaves are used to handle wire rope in a pulley system and must resist wear.

Old Gray iron.

New Ductile iron.

Advantages Gained Service life increased four times because of improved wear resistance. Less tool breakage during fabrication because new material is free from chill as cast.

Source: *International Nickel Co.*



Die for Fabricating Washers

Production run doubled

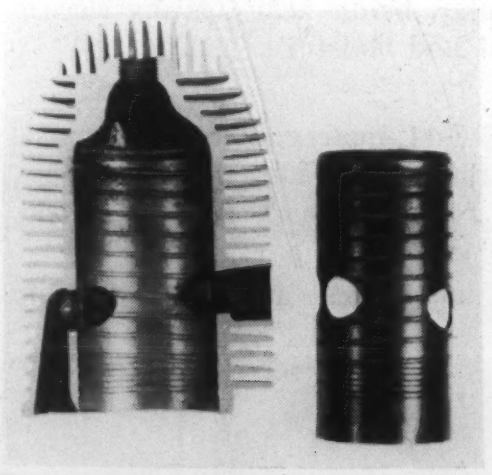
Die used for fabricating washers 0.485 in. o.d. by 0.218 in. i.d. by 0.030 in. thick from spring steel having a hardness of Rockwell C46-47.

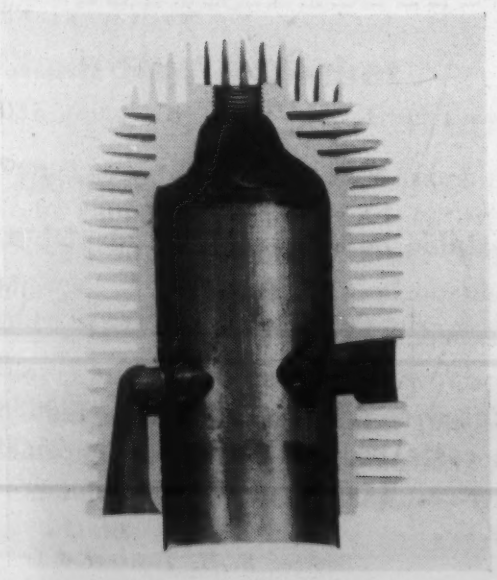
Old High carbon, high chromium steel.

New High speed tool steel.

Advantages Gained Old dies required resharpening after producing 12,000 to 15,000 pieces; new dies produce 35,000 pieces before requiring sharpening. Production runs are doubled and downtime was reduced since dies must be removed from press for sharpening.

Source: *Vandium Alloys Steel Co.*





Cylinder for Light Aircraft Engine

Weight reduced

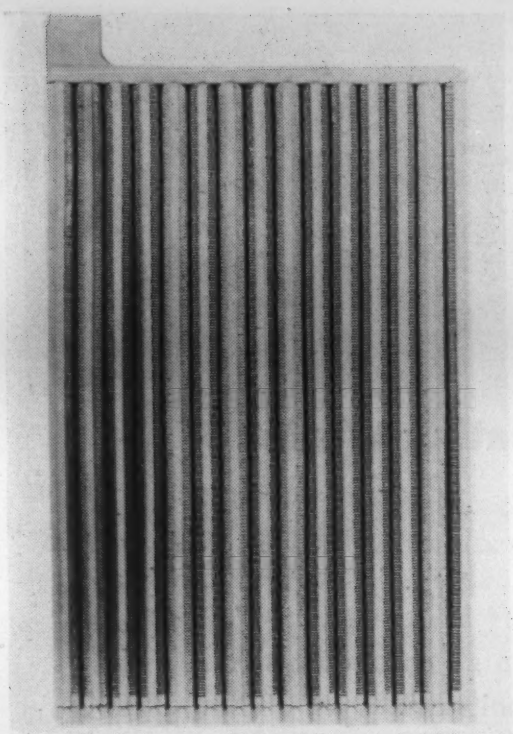
Cylinder for aluminum engine used in Navy's "Flying Platform," the "Gyrodyne" one-man helicopter, Goodyear's collapsible airplane and similar types of aircraft where low weight per horsepower is vital.

Old Cast aluminum with internal steel sleeve to provide a wear resistant bore (top).

New Cast aluminum, the steel sleeve being replaced by a porous chromium electroplate directly on the internal bore surface (bottom).

Advantages Gained Elimination of steel sleeves on four cylinders reduced engine weight to 45 lb and improved heat transfer from bore to fins, thereby providing an unusually high horsepower-weight ratio of 1:1.

Source: *Van der Horst Corp. of America*



Tubes for Storage Battery

Working life increased

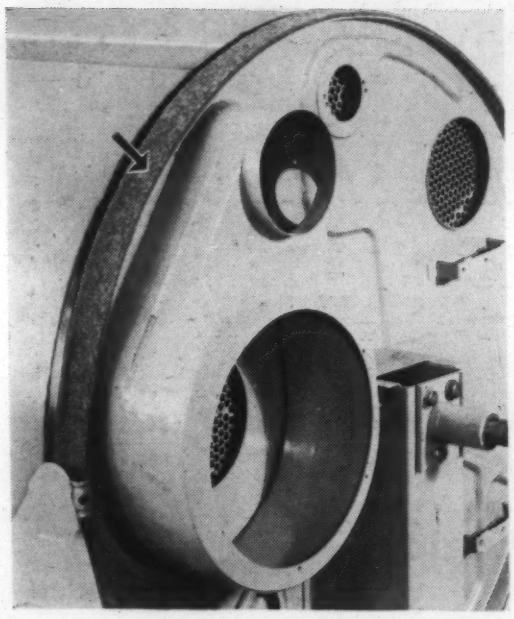
Slotted tubes in industrial storage batteries must hold active material (powdered lead oxide) around the anodic grid spines, yet must permit electrolyte to freely penetrate active material. Sealers at ends of tubes must seal in active material and prevent short circuits. Tubes must be resistant to corrosion, oxidation and attack by battery acid. Tube material must also have good insulation properties and must be capable of being easily and accurately slotted.

Old Rubber tubing.

New Polyethylene tubing.

Advantages Gained Use of polyethylene increases battery working life up to about 20%. During breakdown service life tests, when rubber tube cells deliver only 37-42% of capacity, and flat plate cells only 3-12% of capacity, polyethylene tube cells deliver 80-82% of capacity. Due to the resistance of polyethylene to battery acid, slots retain their dimension and do not permit loss of active material.

Source: *Exide Industrial Div., Electric Storage Battery Co.*



Seals for Home Laundry Dryer

Better heat resistance

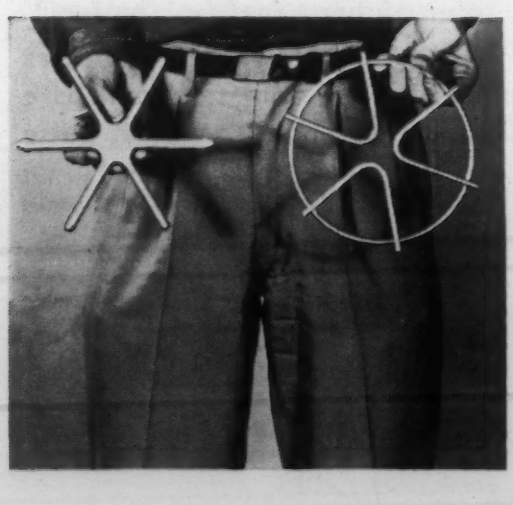
Strips of compressible material that seal dryer drum at front and rear, preventing escape of heated air or entrance of cool air. May be attached to metal rim on inside face of front and rear panels of dryer and held by wire band or stretched over rim of drum and held by steel strapping. Rear drum seal in particular, being near heating element and exhaust box, must withstand heat and moisture.

Old Woven asbestos fabric.

New Wool felt of type similar to SAE F-11, impregnated with a special form of Hycar synthetic rubber for added abrasion resistance, resiliency, tensile strength, moisture resistance and, to some extent, heat resistance. Strip sewn to form endless belt.

Advantages Gained Less shrinkage due to heat and therefore more effective sealing. Also lower cost.

Source: *Western Felt Works*



Burner Grate

Tooling costs cut

Must be light weight to be used in portable burner unit and adaptable to volume production.

Old Die cast aluminum (left).

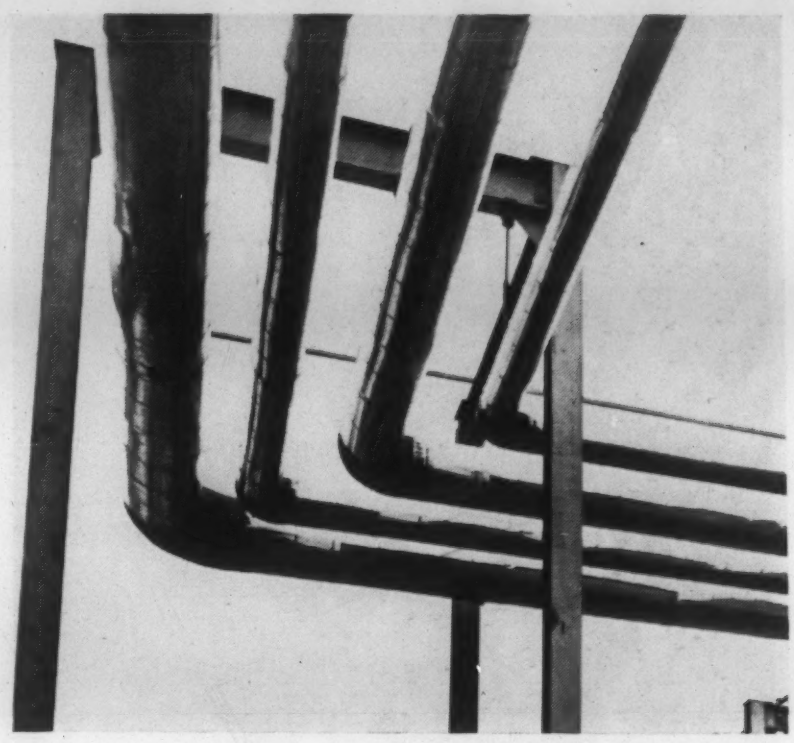
New Welded wire assembly (right).

Advantages Gained Tooling charge for wire design $300 versus $3000 for the die casting. Unit production costs reduced from 30¢ to 25¢. Savings on first order of 25,000 pieces, $4,015. Improved impact resistance because of resiliency of wire.

Source: *E. H. Tichener & Co.*

Barrier-Bond for Insulation Jacket

Improved moisture barrier



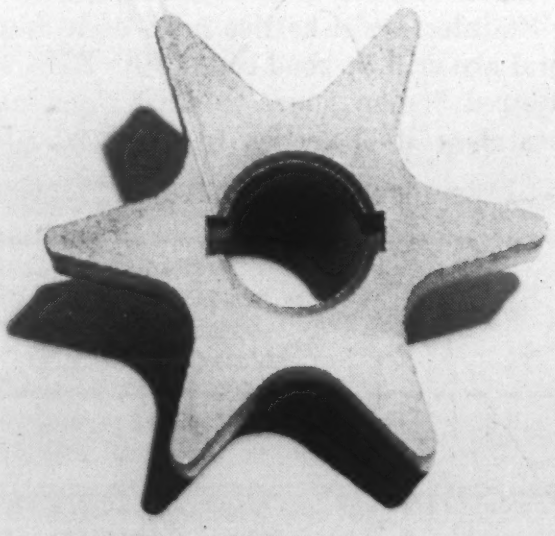
Inner coating for aluminum jacket must provide bond between aluminum and kraft paper liner and act as a moisture barrier.

Old Asphalt coating over kraft paper.

New Polyethylene resin bond between kraft paper and aluminum.

Advantages Gained New bonding material provides effective moisture barrier and permits operation in extremely wet conditions where aluminum is in danger of electrolytic corrosion by some insulating materials. Old bituminous coating had tendency to ooze at high temperatures. Polyethylene bond, however, has tested out successfully from −70 to +350 F. Aluminum jacket has lower installation costs than conventional sewed-on covers, eliminates maintenance, is easily removed and can be re-used when insulation must be changed.

Source: *E. I. du Pont de Nemours & Co., Inc.*



Chain Saw Sprocket

Wear life increased

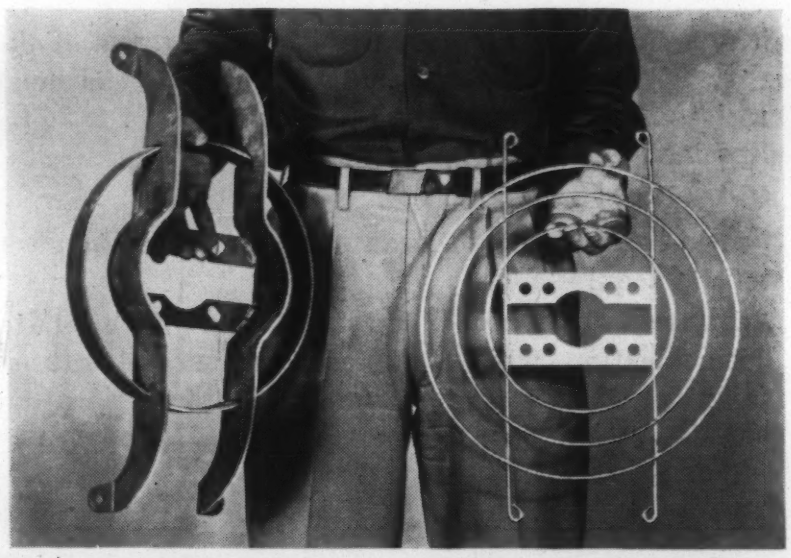
Sprocket subjected to wear from chain and abrasion from sand and soil picked up when cutting trees, stumps, and branches. Must withstand shocks in service. Also exposed to atmospheric corrosion.

Old SAE 52100 steel, quenched and tempered.

New Metal powder part with chromized coating.

Advantages Gained Metal powder part is cheaper than the steel part and chromizing made it sufficiently wear resistant to withstand the severe service conditions.

Source: *Chromalloy Corp.*



Motor Mount for Industrial Heater

Weight reduced

Mount must be light weight but durable. Te reduce noise level to minimum, mount must act as a vibration dampener.

Old Cold rolled steel (left).

New Welded wire assembly (right).

Advantages Gained Weight reduced from 6½ to 1½ lb. Wire design absorbs motor vibrations and reduces noise level. Concentric-circle type construction is easily adapted to various size requirements.

Source: *E. H. Tichener & Co.*

Valve Stems

Corrosion resistance improved

These stems are installed in the water system of the City of Los Angeles in iron valve bodies and must resist galvanic corrosion. Sizes range from 4 to 24 in. Specified tensile strength 60,000 min.

Old Manganese bronze.

New Cast nickel-tin bronze heat treated to meet tensile requirement.

Advantages Gained Old stems were subject to dezincification which weakened them and caused failures. New stem not subject to dezincification because of low zinc content (up to 2%) and life is extended greatly.

Source: *International Nickel Co.*

Kettles for Dyeing Textiles

Service life extended

Part must withstand attack by dyes and must be readily cleaned to avoid contamination.

Old Wood.

New Stainless steel.

Advantages Gained Wooden kettles required replacement after 6 to 12 months, the shorter period applying when caustic soda was used in the dye solution. Stainless steel kettles have been in use for 9 years and are still in good condition. Each wooden kettle required 3 man hours to wash; one man can wash 3 stainless steel kettles in 15 to 20 min.

Source: *Committee of Stainless Steel Producers, AISI*

Drinking Fountain Head

Machining operations cut

Designed to provide smooth jet of water without squirting. Part must lend itself to chromium plating as final fabricating step.

Old Sand-cast copper alloy.

New Brass forging.

Advantages Gained Savings of 45% in polishing operations alone. Smoother surface of brass forgings cut down number of machining operations. Better grain structure resulting in stronger and tougher parts.

Source: *Copper & Brass Research Assn.*

Reprints of this special article are available at 25¢ each until supply is exhausted.

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MATERIALS ENGINEERING FILE FACTS

Properties of Nylon Plastics

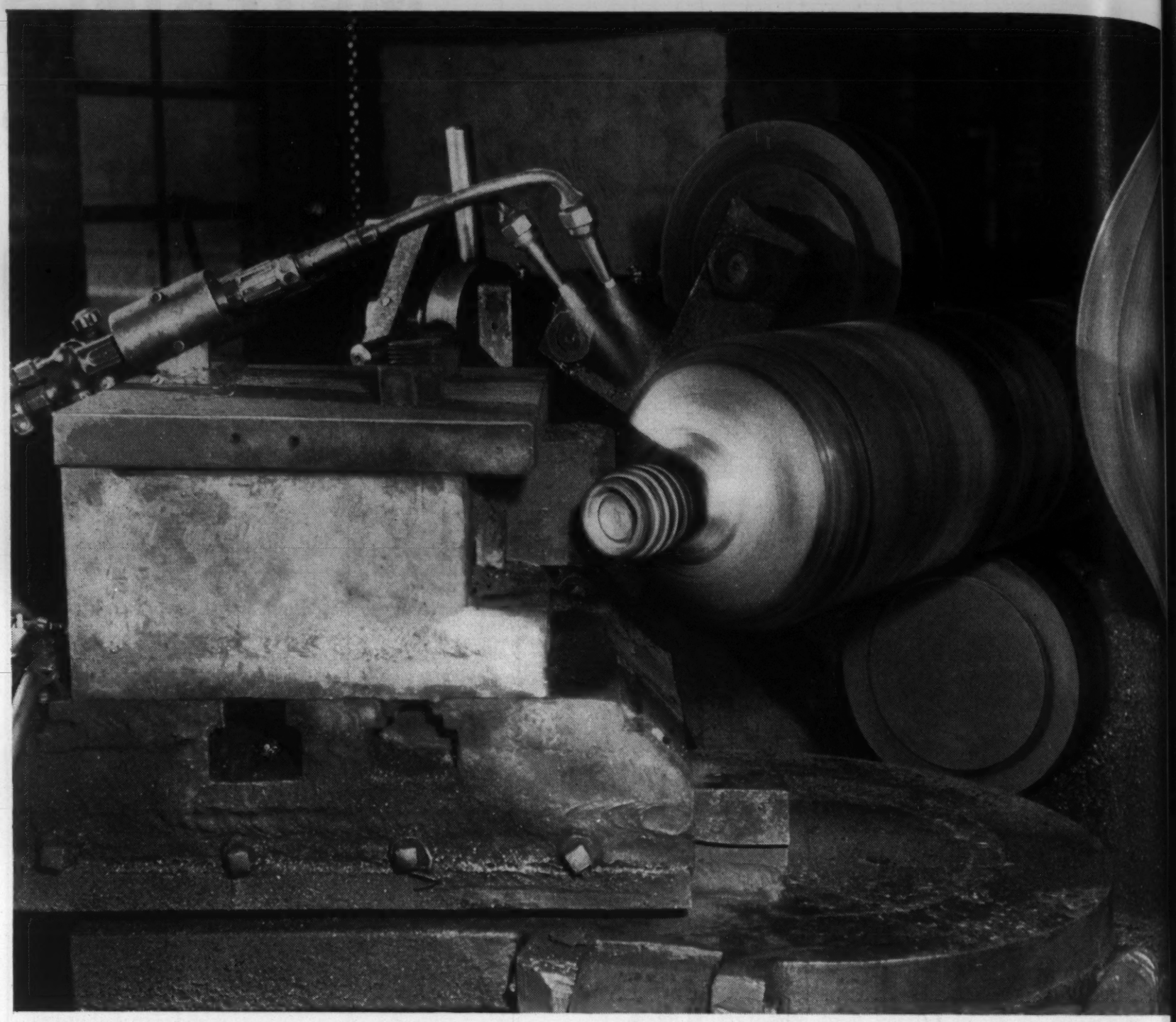
Materials Data Sheet

	ASTM Test Conditions	ASTM Comp. 1 General Purpose Injection Molding (Zytel 101)	ASTM Comp. 2 Extrusion & Injection Molding (Zytel 31)	Solution, Extrusion, Injection (Zytel 63)	Molding (Plaskon 8200)
Physical Properties					
Specific Gravity	D792	1.14	1.09	1.13	1.13
Thermal Cond, Btu/hr/sq ft/ft/F	[1]—	0.14	0.12	0.16	0.14
Coef of Exp. per F	D696	5.5×10^{-5}	8.2×10^{-5}	8.2×10^{-5}	4.6×10^{-5}
Spec Ht, Btu/lb/F	—	0.4	0.4	0.4	0.4
Refractive Index	D542	1.53	1.53	—	—
Water Absorption, 24 hr %	D570	1.5	0.4	2.0	1.6
Flammability	D757	Self extinguishing	Self extinguishing	Self extinguishing	Self extinguishing
Mechanical Properties					
Mod of Elasticity in Tension, psi	D638	4×10^5	1.5×10^5	0.7×10^5	3×10^5
Tensile Str, psi	D638	10,500	7000	7400	12,000
Elong, %	D638	90	90	300	300
Hardness, Rockwell	D785	R118	R111	R83	R118
Impact Str, Izod Notched, ft-lb/in. of notch	D256	1	1	>16	1.2
Mod Elasticity in Flexure, psi	D790	3×10^5	1.5×10^5	0.7×10^5	3×10^5
Flexural Yield Str, psi (approx)	D790	13,800	8000	3800	13,000
Compressive Yield Str, psi (approx)	D695	13,000	7200	—	11,000
Electrical Properties					
Elec Res, ohm-cm	D257	4.5×10^{13}	4.0×10^{14}	5×10^{13}	1.1×10^{14}
Dielectric Str (short time), volts/mil	D149	385	470	420	420
Dielectric Constant:					
60 cycles	D150	4.1	4.6	10.7	4.5
1,000,000 cycles	D150	3.4	3.5	4.5	3.6
Dissipation Factor					
60 cycles	D150	0.014	0.04	0.19	0.03
1,000,000 cycles	D150	0.04	0.03	0.14	0.05
Loss Factor					
60 cycles	D150	0.057	0.18	2.1	0.14
1,000,000 cycles	D150	0.14	0.11	0.63	0.16
Fabricating Properties					
Injection Molding Pressure, psi		10,000-25,000	10,000-25,000	10,000-25,000	10,000-25,000
Injection Molding Temp, F		550-700	410-600	360-500	480-550
Compression Ratio (bulk factor)	D392	2.1	2.2	2.5	2.2
Compression Molding Pressure, psi		—	—	—	—
Compression Molding Temp, F		—	—	380	—
Extruding Temp, F		550-625	450-550	500-550	450-500
Maximum Recommended Service Temp, F		250	230	140	140
Heat Distortion Temp, F (66 psi)		360	300	100	—
Joining		Can be cemented with aqueous phenol or with several other compositions; can be bonded to metal with a proprietary—phenolic adhesive			
Corrosion Resistance		Resistant to esters, ketones, alkalies, weak acids, alcohols, common solvents. Not resistant to phenols, formic acid, con. mineral acids		Resistant to ketones, alkalies, esters. Not resistant to alcohols, phenols, formic acid, acids	Resistant to esters, ketones, alkalies, weak acids, alcohols, common solvents. Not resistant to phenols, formic acid, con. mineral acids
Uses		Gears, bearings, mechanical parts, in automotive, industrial and household equipment	Jacketing for wire and cable, special molded parts	Jacketing for wire and cable, seals, packings, sheeting	Bearings, gears, bushings, coil-forms, brush-backs, rod, tubing, tape, monofilament, film

[1] *Cenco Fitch*

Prepared with the assistance of E. I. Du Pont de Nemours & Co., Inc., and Barrett Div., Allied Chemical & Dye Corp.

For more information, Circle No. 583



How to bottle up 2400 psi

The Marison Company of South Elgin, Ill., is a leading producer of industrial oxygen cylinders manufactured to hold this active gas at 2400 psi. From its beginning, Marison has consistently used Seamless Tubing for this task.

Marison has found B&W Seamless Tubing to be ideal for its complicated cycle of spinning, forming, heat-treating and threading operations. Every ounce and every inch of tubing—and every operation by Marison—must be flawless in every respect to meet the demands of these pressure cylinders.

Whatever your requirements in tubing...for consistently high and uniform quality...for top service ...look to B&W. For more information on selection and use of carbon, alloy or stainless steel tubing, write for Bulletin 361 or call in Mr. Tubes, your nearby B&W Tube Representative. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W TUBULAR PRODUCTS DIVISION

TA-50

Seamless and welded tubular products, seamless welding fittings and flanges—in carbon, alloy and stainless ste

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MATERIALS ENGINEERING FILE FACTS

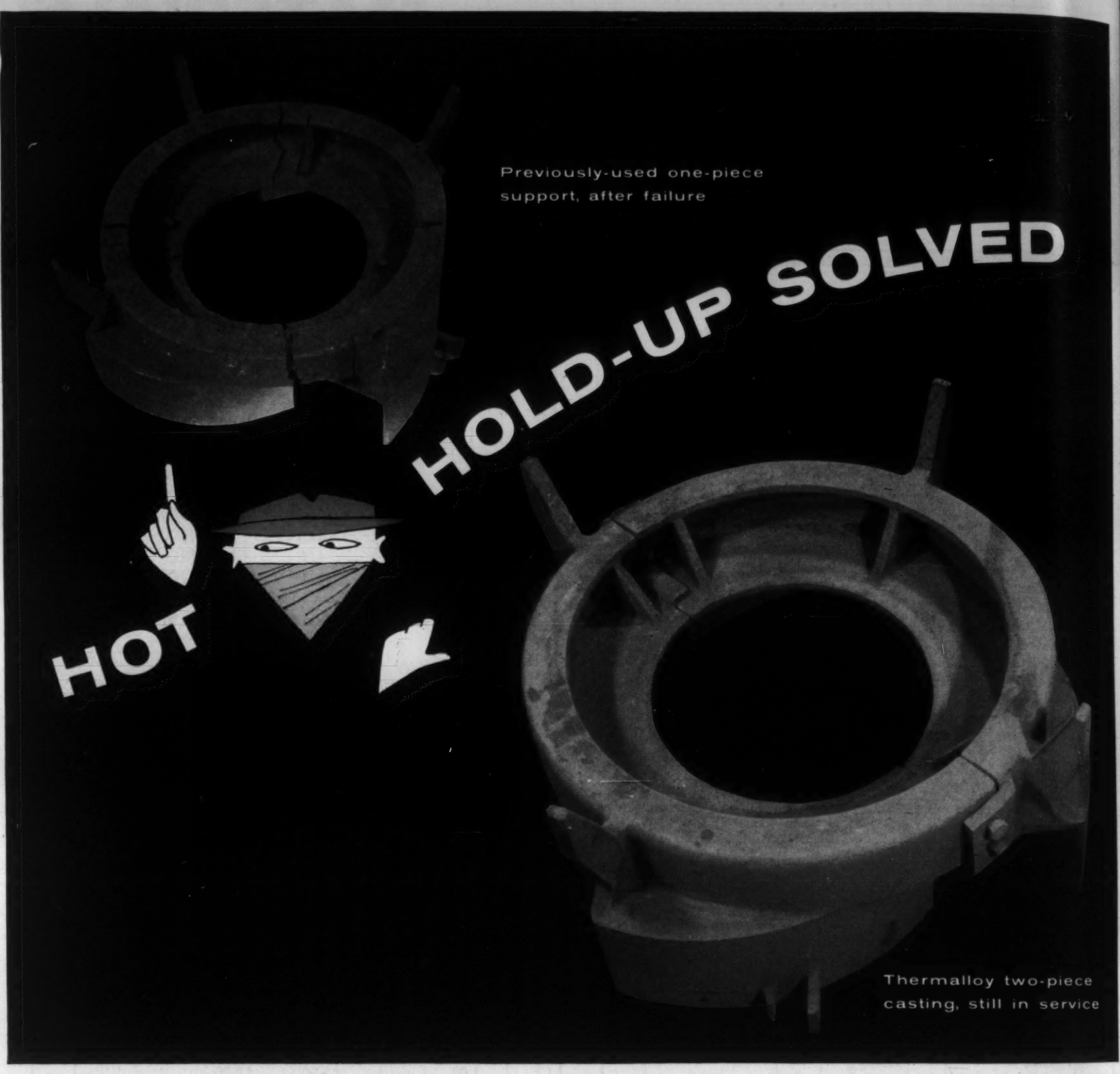
Tool Steels – Identification and Type Classification

Type	Identifying Elements, % C	Mn	Si	Cr	Ni	V	W	Mo	Co	Cb
Water Hardening Tool Steels—Symbol W										
W1	0.61/1.40[a]	—	—	—	—	—	—	—	—	—
W2	0.60/1.40[a]	—	—	—	—	0.25	—	—	—	—
W3	1.00	—	—	—	—	0.50	—	—	—	—
W4	0.60/1.40[a]	—	—	0.25	—	—	—	—	—	—
W5	1.10	—	—	0.50	—	—	—	—	—	—
W6	1.00	—	—	0.25	—	0.25	—	—	—	—
W7	1.00	—	—	0.50	—	0.20	—	—	—	—
Shock Resisting Tool Steels—Symbol S										
S1	0.50	—	—	1.50	—	—	2.50	—	—	—
S2	0.50	—	1.00	—	—	—	—	0.50	—	—
S3	0.50	—	—	0.75	—	—	1.00	—	—	—
S4	0.55	0.80	2.00	—	—	—	—	—	—	—
S5	0.55	0.80	2.00	—	—	—	—	0.40	—	—
Cold Work Tool Steels—Symbol O Oil Hardening Types										
O1	0.90	1.00	—	0.50	—	—	0.50	—	—	—
O2	0.90	1.60	—	—	—	—	—	—	—	—
O7	1.20	—	—	0.75	—	—	1.75	—	—	—
Cold Work Tool Steels—Symbol A Medium Alloy Air Hardening Types										
A2	1.00	—	—	5.00	—	—	—	1.00	—	—
A4	1.00	2.00	—	1.00	—	—	—	1.00	—	—
A5	1.00	3.00	—	1.00	—	—	—	1.00	—	—
A6	0.70	2.00	—	1.00	—	—	—	1.00	—	—
Cold Work Tool Steels—Symbol D High Carbon-High Chromium Types										
D1	1.00	—	—	12.00	—	—	—	1.00	—	—
D2	1.50	—	—	12.00	—	—	—	1.00	—	—
D3	2.25	—	—	12.00	—	—	—	—	—	—
D4	2.25	—	—	12.00	—	—	—	1.00	—	—
D5	1.50	—	—	12.00	—	—	—	1.00	3.00	—
D6	2.25	—	1.00	12.00	—	—	1.00	—	—	—
D7	2.35	—	—	12.00	—	4.00	—	1.00	—	—
Hot Work Tool Steels—Symbol H Chromium Base Types, H1-H19, incl (H1-H10 and H17-H19 Unassigned)										
H11	0.35	—	—	5.00	—	0.40	—	1.50	—	—
H12	0.35	—	—	5.00	—	0.40	1.50	1.50	—	—
H13	0.35	—	—	5.00	—	1.00	—	1.50	—	—
H14	0.40	—	—	5.00	—	—	5.00	—	—	—
H15	0.40	—	—	5.00	—	—	—	5.00	—	—
H16	0.55	—	—	7.00	—	—	7.00	—	—	—
Hot Work Tool Steels—Symbol H Tungsten Base Types, H20-H39, incl (H27-H39 Unassigned)										
H20	0.35	—	—	2.00	—	—	9.00	—	—	—
H21	0.35	—	—	3.50	—	—	9.00	—	—	—
H22	0.35	—	—	2.00	—	—	11.00	—	—	—
H23	0.30	—	—	12.00	—	—	12.00	—	—	—
H24	0.45	—	—	3.00	—	—	15.00	—	—	—
H25	0.25	—	—	4.00	—	—	15.00	—	—	—
H26	0.50	—	—	4.00	—	1.00	18.00	—	—	—
Hot Work Tool Steels—Symbol H Molybdenum Base Types, H40-H59, incl (H40, H44-H59 Unassigned)										
H41	0.65	—	—	4.00	—	1.00	1.50	8.00	—	—
H42	0.60	—	—	4.00	—	2.00	6.00	5.00	—	—
H43	0.55	—	—	4.00	—	2.00	—	8.00	—	—

Type	Identifying Elements, % C	Mn	Si	Cr	Ni	V	W	Mo	Co	Cb
High Speed Tool Steels—Symbol T Tungsten Base Types										
T1	0.70	—	—	4.00	—	1.00	18.00	—	—	—
T2	0.80	—	—	4.00	—	2.00	18.00	—	—	—
T3	1.05	—	—	4.00	—	3.00	18.00	—	—	—
T4	0.75	—	—	4.00	—	1.00	18.00	—	5.00	—
T5	0.80	—	—	4.00	—	2.00	18.00	—	8.00	—
T6	0.80	—	—	4.50	—	1.50	20.00	—	12.00	—
T7	0.75	—	—	4.00	—	2.00	14.00	—	—	—
T8	0.75	—	—	4.00	—	2.00	14.00	—	5.00	—
T9	1.20	—	—	4.00	—	4.00	18.00	—	—	—
T15	1.50	—	—	4.00	—	5.00	12.00	—	5.00	—
High Speed Tool Steels—Symbol M Molybdenum Base Types										
M1	0.80	—	—	4.00	—	1.00	1.50	8.00	—	—
M2	0.80	—	—	4.00	—	2.00	6.00	5.00	—	—
M3	1.00	—	—	4.00	—	2.70	6.00	5.00	—	—
M4	1.30	—	—	4.00	—	4.00	5.50	4.50	—	—
M6	0.80	—	—	4.00	—	1.50	4.00	5.00	12.00	—
M7	1.00	—	—	4.00	—	2.00	1.75	8.75	—	—
M8[c]	0.80	—	—	4.00	—	1.50	5.00	5.00	—	—
M10	0.85	—	—	4.00	—	2.00	—	8.00	—	—
M15	1.50	—	—	4.00	—	5.00	6.50	3.50	5.00	—
M30	0.80	—	—	4.00	—	1.25	2.00	8.00	5.00	—
M34	0.90	—	—	4.00	—	2.00	2.00	8.00	8.00	—
M35	0.80	—	—	4.00	—	2.00	6.00	5.00	5.00	—
M36	0.80	—	—	4.00	—	2.00	6.00	5.00	8.00	—
Special Purpose Tool Steels—Symbol L Low Alloy Types										
L1	1.00	—	—	1.25	—	—	—	—	—	—
L2	0.50/1.10[a]	—	—	1.00	—	0.20	—	—	—	—
L3	1.00	—	—	1.50	—	0.20	—	—	—	—
L4	1.00	0.60	—	1.50	—	0.25	—	—	—	—
L5	1.00	1.00	—	1.00	—	—	—	0.25	—	—
L6	0.70	—	—	0.75	1.50	—	—	0.25[b]	—	—
L7	1.00	0.35	—	1.40	—	—	—	0.40	—	—
Special Purpose Tool Steels—Symbol F Carbon Tungsten Types										
F1	1.00	—	—	—	—	—	1.25	—	—	—
F2	1.25	—	—	—	—	—	3.50	—	—	—
F3	1.25	—	—	0.75	—	—	3.50	—	—	—
Mold Steels—Symbol P Low Carbon Types, P1-P19, incl (P7-P19 Unassigned)										
P1	0.10	—	—	—	—	—	—	—	—	—
P2	0.07	—	—	2.00	0.50	—	—	0.20	—	—
P3	0.10	—	—	0.60	1.25	—	—	—	—	—
P4	0.07	—	—	5.00	—	—	—	—	—	—
P5	0.10	—	—	2.25	—	—	—	—	—	—
P6	0.10	—	—	1.50	3.50	—	—	—	—	—
Other Types P20-P39, incl (P21-P39 Unassigned)										
P20	0.30	—	—	0.75	—	—		0.25	—	—

[a] Varying carbon contents may be available.
[b] At producer's option.
[c] Also contains 1.25% columbium.

Courtesy American Iron and Steel Institute



Thermalloy* outlasts previous part 4 to 1

. . . and still going strong. This "hold-up" is not as flashy as the bank or jewelry store variety. But, at one time, it was just as costly to the Diamond Chain Company . . . in lost production time.

The parts shown in the illustration were used to protect the fan in a popular, pit-type carburizing furnace. This fan was originally protected by a one-piece work support (shown above at left) which held a heavy parts-basket. This support proved unsatisfactory . . . often cracking after only 1000 to 1500 hours of use. Repairing the work support gave 1500 to 2000 hours of additional service, but required costly down time.

Diamond Chain proposed using a two-piece work support . . . which was designed by Electro-Alloys in co-operation with the manufacturer. The results—*four times* the service life of the one-piece support—and the Thermalloy casting is *still going strong!*

Let us show you how our engineering skill and design experience on furnace and heat-treat parts can save *you* money! Contact your local Electro-Alloys representative or write Electro-Alloys Division, 7001 Taylor Street, Elyria, Ohio. *Reg. U. S. Pat. Off.

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AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
Elyria, Ohio

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NEW MATERIALS PREVIEWS

This month

- *More polyethylene resins*
- *Self-insulated aluminum wire*
- *Silicone rubbers for thick parts*

Two New Polyethylenes fill the gap

		Conventional[a]	Alathon 37, 34	Alkathene HD	High Density[b]
Density	D792-50	0.92	0.93	0.94	0.93-0.96
Melt Index, g/10 min	D1238-52T	2.1	12.0, 1.9	0.7	0.1-4.0
Ten Str, psi	D412-51T	1400-1750	2000, 2300	2900[c]	—[d]
Yield Str, psi	D412-51T	1300-1700	1900	—	—
Stiffness Modulus, x 10^3 psi	D747-50	13-27	43, 45	50	50-140
Elongation, %	D412-51T	600-650	200	200[c]	—[d]
Hardness, Shore D	D676-49T	45-48	55	—	63-70
Vicat Softening Point, F	—	176-201	215, 220	240	240-260
Brittleness Temp, F	D746-51T	<−105 to <−90	<−148	<−94	<−100 to <−180

[a] Range of properties covers those of Alathon 10 and Alathon 14 (Du Pont).
[b] Range of properties covers those of Super Dylan (Koppers Co.) and Marlex 50 (Phillips Chemical Co.).
[c] Values obtained at cross-head speed of 18 in./min.
[d] Only values available were obtained by ASTM D638-52T: 2800-5500 psi tensile strength and 28-400% elongation.

■ Two new types of polyethylene resins have been developed to fill the gap between conventional. "low density" (branched-chain) resins and the new high density (linear) polyethylenes. *(For more information on high density polyethylenes see* M&M, *July '55 p 88.)* The new materials are more crystalline than conventional polyethylenes and therefore have greater heat resistance, stiffness and tensile strength. Since crystallinity varies with density, the differences in properties between the new materials and presently available or recently announced polyethylenes are reflected to a considerable degree by their differences in density. Densities of the new materials are 0.93 and 0.94, compared with 0.92 for conventional resins and 0.93-0.96 for the new linear polyethylenes.

The resins

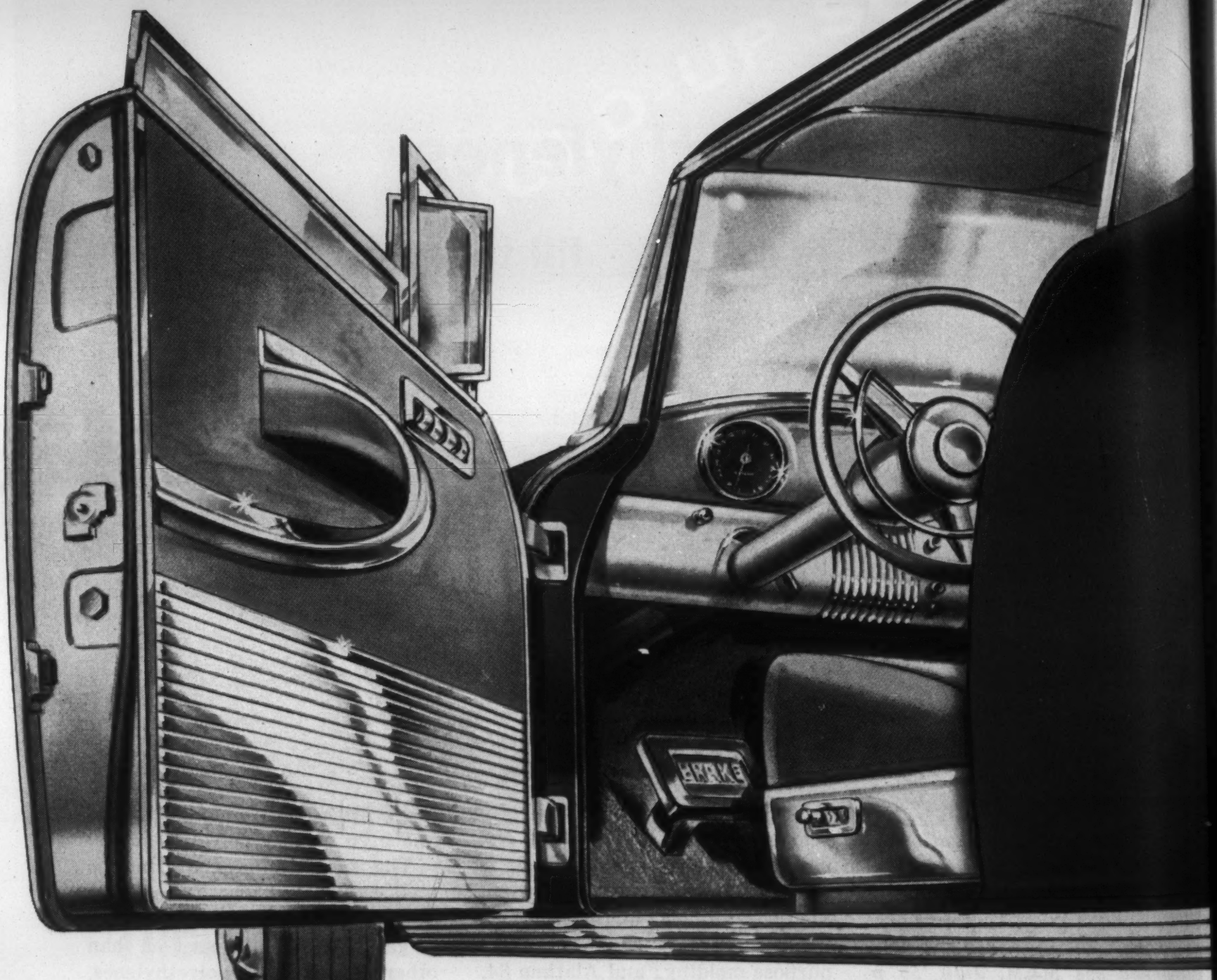
The 0.93-density material developed by *E. I. du Pont de Nemours & Co.*, Wilmington, Del., is available in two forms: Alathon 37, a high-flow material (melt index 12) intended for general purpose molding; and Alathon 34, a low-flow material (melt index 1.9) intended for use in films and bottles. The 0.94-density material, developed by *Imperial Chemical Industries Ltd.*, Imperial Chemical House, Milbank, London S.W.1, England, is called Alkathene HD and is currently available in developmental quantities. These new resins are not produced by the Ziegler or Phillips catalytic processes but simply through modification of the conventional high-pressure process for polymerizing ethylene. The table above shows some typical properties of the new resins compared with those of conventional and high density polyethylenes.

The new resins are nontoxic and essentially free from taste and odor. They are less permeable to gases, liquids and greases than other conventional polyethylenes, and have approximately the same degree of resistance to chemicals. Powerful oxidizing agents, such as 100% sulfuric and nitric acids and concentrated hydrogen peroxide, may cause some loss of strength on prolonged exposure.

The only common solvents that seriously affect the resins are chlorinated hydrocarbons and a few aromatic and aliphatic hydrocarbons. These tend to swell and weaken the material at room temperature but do not dissolve it.

The Du Pont resins are priced at 43¢ per lb in truckload quan-

S.A.* *for tomorrow's car*



* *Sales Appeal*

Attraction — Car dealers report the rich, luxurious interiors, made sible only through the generous use of stainless steel trim, have a defi sales appeal to modern day car buyers. But that's only half of it!

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tities. The I.C.I. resin will be priced initially at about 56¢ per lb. Compounds with carbon black or antioxidant, or both, will also be available at higher prices.

Applications

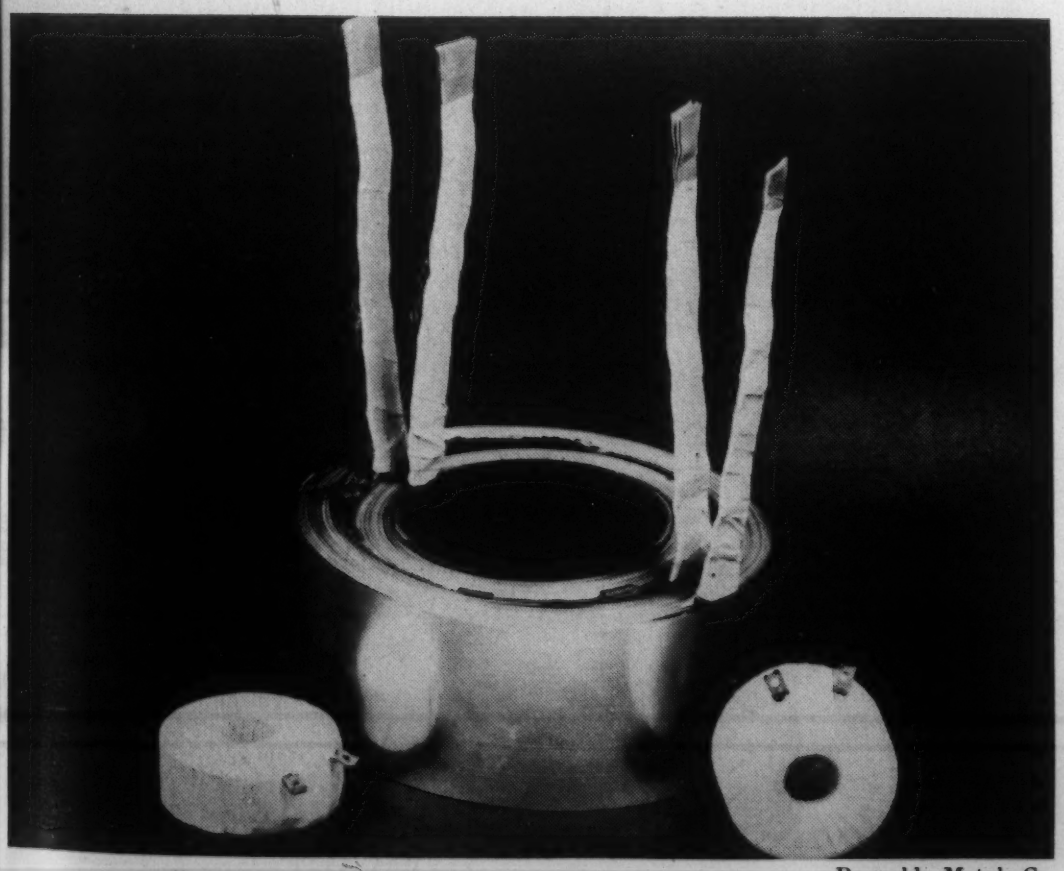
Good molding characteristics make the resins suitable for a variety of applications. Their high degree of stiffness can be used to particular advantage in thin-walled products such as food containers, dishpans, wastebaskets, mixing bowls and tumblers. Higher setting temperatures of the resins also permit ejection of parts from molds at higher temperatures, thereby shortening molding cycles. Alathon 37 is particularly recommended for use where shorter molding cycles are desired, since its low melt viscosity permits faster mold fill-out.

Alathon 34 can be used to produce a transparent film which is considerably stiffer than conventional polyethylene films. Films made of the resin are three to ten times less permeable to liquids, gases and greases than films of Du Pont's Alathon 10, a conventional polyethylene. For films of optimum toughness, Du Pont recommends using the blown film process with a high blow-up ratio. Alathon 34 is also recommended for use in squeeze bottles, where its stiffness permits thinner wall sections and provides superior "snap-back."

Alathon 34 and Alkathene HD should be of interest as coatings for wire and cable because of their superior high and low temperature properties. They are also extremely resistant to deformation under prolonged loading, and have abrasion resistance superior to that of conventional polyethylenes.

Alathon 37, in addition to its applicability as a general purpose molding resin, should be of interest as a coating for paper. In such an application its superior grease resistance and low water vapor transmission rate would be advantageous. Its high melt index permits rapid application to paper and use of a low heat-seal temperature.

Self-Insulated Aluminum Strip and Wire

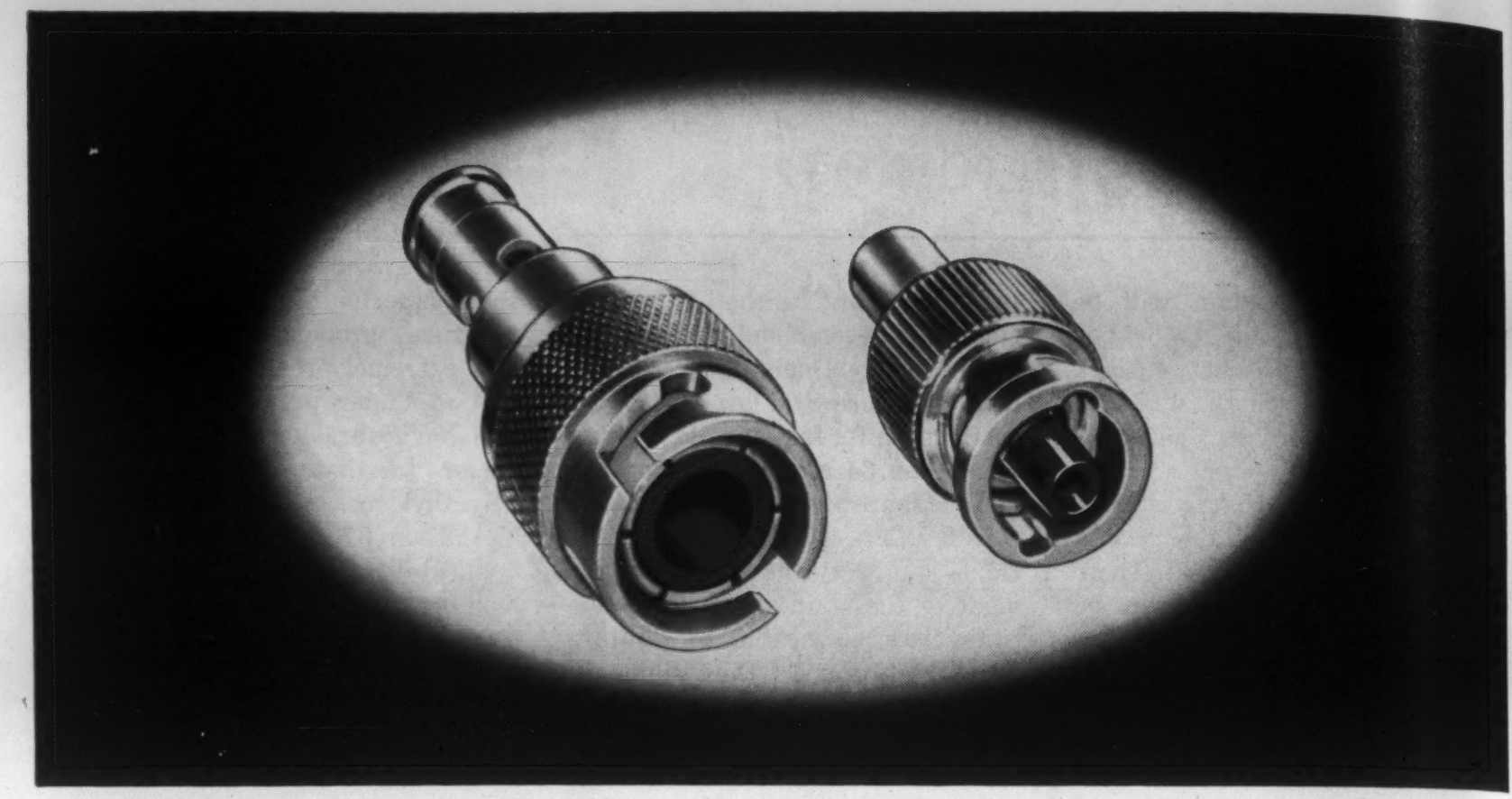


Reynolds Metals Co.

Anodized aluminum strip *conductor wound in large coil for 10 kva transformer. Small conductor coils are wound with aluminum foil and polyester film.*

■ Increasing use of aluminum in the electrical industry has spurred the development of aluminum sheet and strip integrally insulated by an anodic film. Though the insulating properties of aluminum oxide films formed by anodizing have long been known, the film is normally so inherently brittle that forming operations such as coil winding have not been feasible.

Last September *Reynolds Metals Co.*, 2500 S. 3rd St., Louisville, Ky., announced the development of anodized aluminum strip, which could be spiral-wound on coils, replacing wire as well as the paper, glass or enamel insulation normally used with wire coils. Last month Aluminium Co. of Canada also announced the development of a process for rapidly anodizing aluminum wire and strip to produce an insulating layer ductile enough for normal forming. Anodized strip is available from Reynolds. Alcan is planning to license its anodizing process to electrical manufacturers through *Aluminium Lim-*



PRECISION CONNECTORS with KEL-F plastic parts have high RF insulation and dimensional stability. Plastic's high impact and compressive strength permit rough handling without chipping, cracking, or deforming. Zero moisture absorption and anti-adhesive surface prevent formation of conductive residue.

KEL-F® FLUOROCARBON PLASTIC

permits components to operate over a wider temperature range . . . under highly humid and corrosive atmospheres

KEL-F plastic's unique combination of properties can help your product meet more rigid performance specifications. Because of the extreme stability of the fluorocarbon plastic molecule, this dense, tough thermoplastic has superior dielectric properties, excellent resistance to corrosive chemicals, outstanding thermal and dimensional stability, and zero moisture absorption.

Molded and extruded parts operate over an extremely wide range of temperatures (−320° F. to 390° F.) . . . are unaffected by humidity or operational vibration. Metal inserts, lugs and contacts are held firmly, forming a hermetic seal.

KEL-F plastic is available from Kellogg as a molding material, or in sheets, rods, strips, tubing, film and "spaghetti" from qualified fabricators and molders throughout the country. For further information, write: The M. W. Kellogg Company, Chemical Manufacturing Division, P. O. Box 469, Jersey City 3, N. J.

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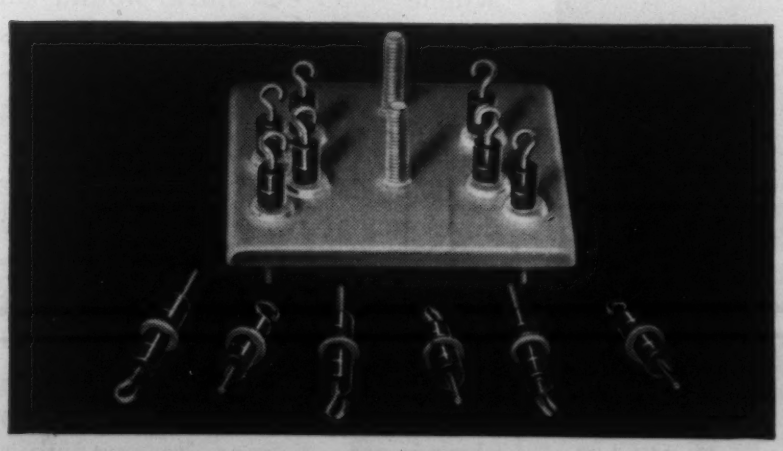
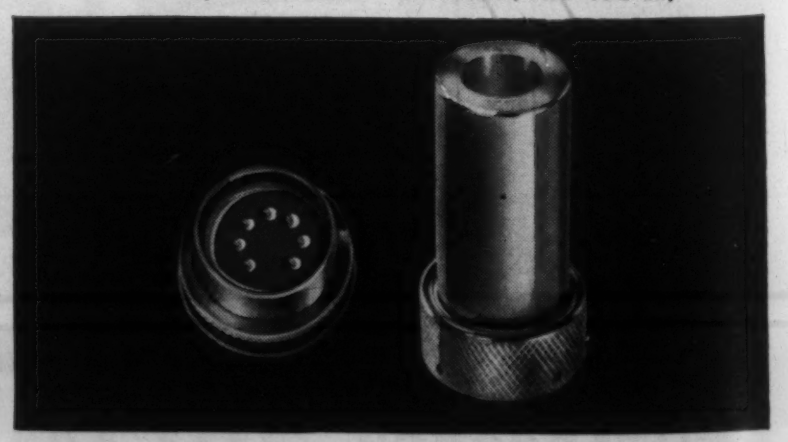


HERMETICALLY-SEALED TERMINALS with KEL-F plastic insulation handle high voltage without flash-over or tracking. Won't shrink, swell, age or lose hermetic seal at high and low operating temperatures. Can be used in contact with highly corrosive chemicals.



TUBE SOCKETS of tough KEL-F plastic. Hermetic seal defies thermal cycling, aging and humidity. Withstands high shock loads without chipping or cracking insulation. Plastic's high dielectric strength prevents shorting or arc-over at high altitudes.

For more information, turn to Reader Service Card, Circle No. 385

ited Sales, Inc., 630 5th Ave., New York 20.

Strip and foil

According to both companies, leading electrical equipment manufacturers in this country have experimented with the material and have found it highly promising. Reynolds' approach is to use strips of aluminum foil or thin sheet, instead of wire, to wind electromagnetic coils for transformers, solenoids and some motors and generators. Use of the strip is said to eliminate the need for the normal layer insulation and to eliminate voids in completed windings, thereby resulting in a reduction in size of coils. In most cases, coil weight is said to be approximately half that of comparable copper units. The high melting point of aluminum oxide is also said to reduce the possibility of a coil burning out.

At present, Reynolds is producing this type of strip in thicknesses of 0.004 to 0.040 in. The anodic film is approximately 0.2-0.3 mils thick, and the company recommends a minimum bend radius of ½ in. There is some indication that this minimum radius can be reduced in the future.

Wire

With coatings thick enough to withstand breakdown voltages up to 250 v, Alcan's wire is said to remain ductile enough for normal handling in fabrication. For example, wire having a breakdown voltage of 250 v can be bent around a mandrel having a diameter only three times the wire diameter. For breakdown voltages higher than 250 v, the coating must be so thick that handling characteristics become much less favorable.

According to Alcan, the coated wire has a high degree of abrasion resistance which can be varied during processing to meet specific end uses. There seems to be no appreciable change in electrical characteristics of the anodized wire with either age or temperatures up to 575 F. To extend the use of this type of wire, Alcan is investigating new sealing procedures that will better exclude moisture. In its present form, the wire may be directly applied to equipment operating in high temperatures provided that moisture is excluded and that coils are oil-immersed in normal operation and coated with a moisture-proof compound after winding.

Four Silicone Rubber Compounds

■ Four silicone rubber compounds, two designed for rapid one-step thick-section curing, the other two said to have good resistance to live steam and low moisture absorption, have been marketed by *Silicones Div., Union Carbide and Carbon Corp.*, 30 E. 42nd St., New York 17. The compounds are based on W-96 gum stock (*see* M&M, *Oct '55, p 146*) which is said to provide the materials with very low compression set characteristics without the use of toxic additives.

K-1025 and K-1028 compounds can be cured quickly in thick sections in one step with di-tertiary-butyl peroxide (DTBP) catalyst, and are therefore particularly suitable for use in rollers, moldings or extrusions where thick sections are necessary. K-1025 is a 50-durometer-hardness material that, when cured, meets or exceeds AMS 3302B and ASTM TA 505 (B, E_1, E_3, F_2 and L) specifications. K-1028 is an 80-durometer-hardness material that meets or exceeds AMS 3305C and ASTM TA 805 (B, E_1, E_3, F_2 and L) specifications.

K-1035 and K-1038 compounds have good live-steam resistance and low moisture absorption, and can also be catalyzed with DTBP. K-1035 is a 50-durometer-hard-

CORRECTION

In the article on "Polymethylstyrene and methylstyrene-acrylonitrile copolymer" which appeared in the March issue, pp 145 and 147, the following corrections should be noted:

1. Page 145, par 3, and p 147, par 1—All shrinkage data refer to parts made in commercial molds at normal production cycles.

2. Page 145, col 2, line 3—The sentence should read as follows: "When a 1/2 x 1/2 x 5-in. test bar with a 264 psi load is immersed in water at 212 F, it distorts approximately 0.060 in. after 15 min; under the same conditions general purpose polystyrenes distort 1 in. in 4 min, and heat resistant polystyrenes distort anywhere from 0.14 in. in 15 min to 1 in. in 12 min."

3. Page 147, col 1, line 9—Distortion of the standard test bar at 212 F was determined in boiling water, and the amount of distortion under the 264 psi load was 0.060 in. (not 0.35-1.0 in.) in 15 min.

4. Page 147, col 1, line 15—Shrinkage figure should be 0.8%, not 8% as given.

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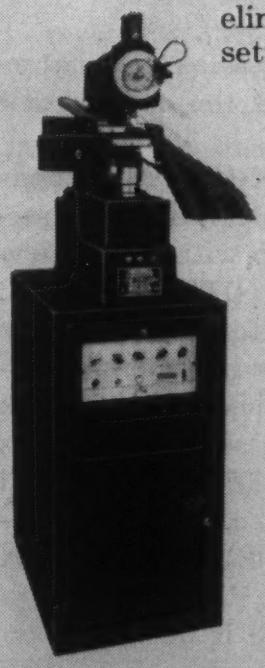

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ness material that meets AMS 3302B and ASTM TA 505 (B, E_1, E_3, F_2 and L) specifications. K-1038 is an 80-durometer-hardness material that meets or exceeds AMS 3305C and ASTM TA 805 (B, E_1, E_3, F_2 and L) specifications.

All four compounds are available in neutral or red color. They are normally shipped uncatalyzed to allow fabricators to select the catalyst best suited for individual applications. All four can also be supplied with benzoyl peroxide catalyst on special order.

OTHER NEW MATERIALS, PRODUCTS

Anodized Aluminum Colored Without Dyes

Gold-colored aluminum, in a variety of shades, can now be produced by a new method that eliminates use of dyes. The coloring element is added to the molten aluminum during production. Color of the resulting alloy is that of normal aluminum, and remains so until it is anodized, at which time it takes on a nonfading gold color. The gold color may be varied from pale straw to deeper gold and gold-bronze, and the finish may be either bright or satin.

Developed by *Kaiser Aluminum & Chemical Corp.*, 1924 Broadway, Oakland 12, Calif., the process is said to provide excellent color matches by eliminating uncertainties involved when dyes or other coloring agents are used. (For information on dyed anodized aluminum see M&M, Dec. '55, p 145.) Finishing processes are also said to be simplified.

As is the case with existing anodic finishes, the new gold finish increases corrosion protection and resistance to wear. The color resists exposure to sunlight and to boiling water. Colored aluminum is expected to find application in automotive trim, furniture, home appliances and architectural exteriors.

For most applications the new

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what's new ?

NUMBER 32 OF A SERIES

seven hardening jobs on one flamatic

You might look for a lot of fancy tooling on the Standard Flamatic that hardens all these jobs. You won't find it.

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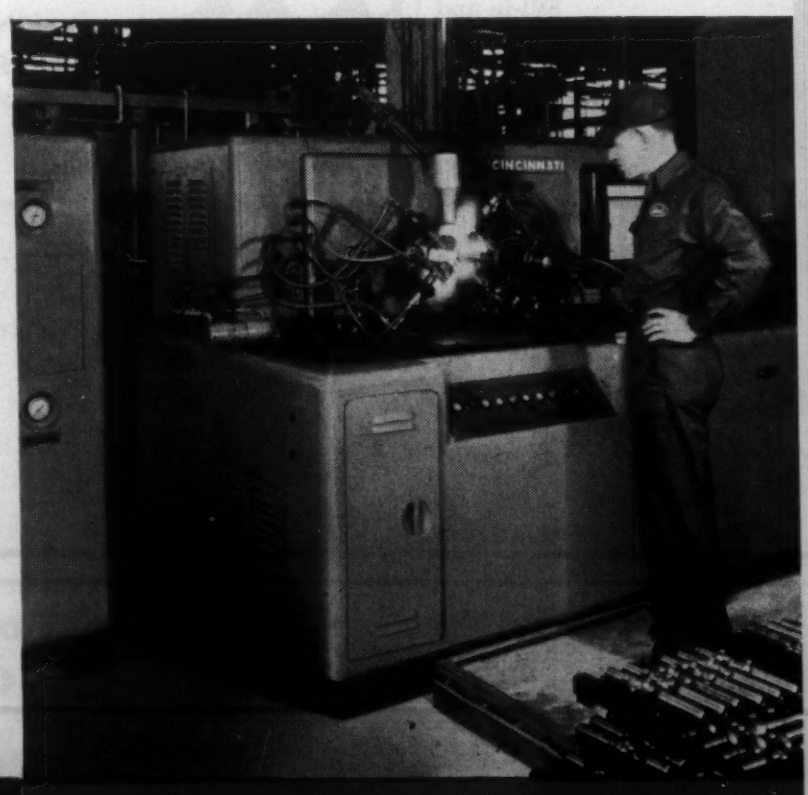

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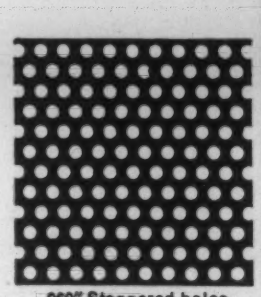

.060" Staggered holes. 126 holes per sq. in. 3/32" centers. 36% open.

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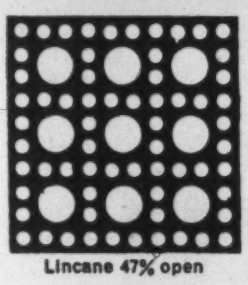

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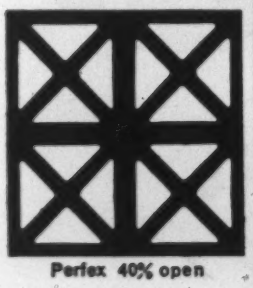
Perforating all metals, Masonite, plywood, paper, cloth and plastic.



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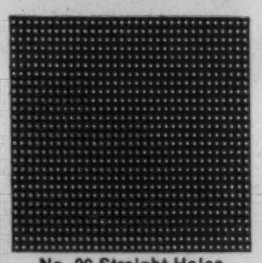

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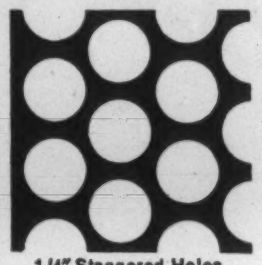
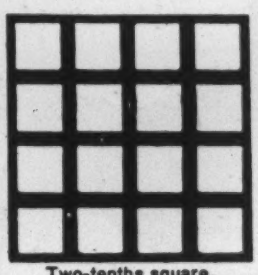


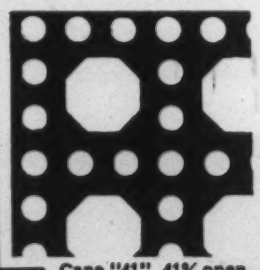
1/4" Staggered Holes. 5/16" centers. .25" diam. 58% open.

See our catalog in Sweet's Product Design File.



Two-tenths square, 64% open.

Round holes, square holes, slots, ornamental patterns, oblong holes, oval holes.



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OTHER NEW MATERIALS, PRODUCTS

alloy, which will soon be available in sheet form, will be applied as cladding on standard aluminum alloy sheets. Development work is now in progress aimed at adapting the gold alloy product to other forms, such as extrusions.

Fast Conversion Coating for Aluminum

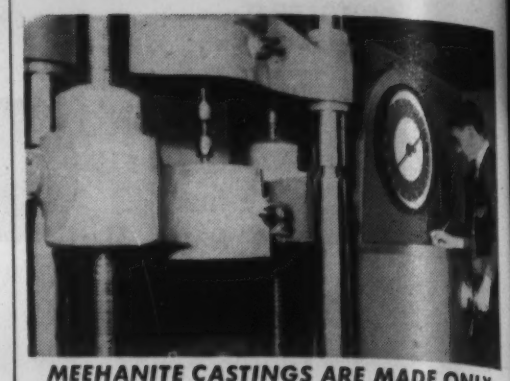
A conversion coating for aluminum which becomes fixed and nonsmearing immediately upon application has been marketed by *Turco Products, Inc.*, 6135 S. Central Ave., Los Angeles 1. The protective coating is integral with the metal surface and meets the MIL-C-5541 specification. It is acid resistant and has relatively low electrical resistance. It is also ductile, allowing the metal to be formed after the coating is applied.

Called Turcoat 4178, the material can be applied by immersion, spray washer or conventional hand methods. The coating formed is a thin, smooth, noncrystalline film with a slight metallic luster. Its color is a light golden yellow, with red and greenish iridescence. Coated parts can be handled freely while wet without smudging or streaking.

Furnished in dry powdered form, the material is free from objectionable odors and dangerous fuming. The process is said to be easy to control, pH being the only critical variable. Standard temperatures and concentrations are generally observed. Only slight sludging is encountered and does not interfere with tank operations.

Nylon Dispersion for Coating, Bonding

A new nylon emulsion is suitable for a variety of bonding, coating and textile finishing applications. Formulated by *Belding*



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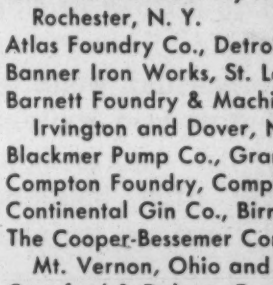

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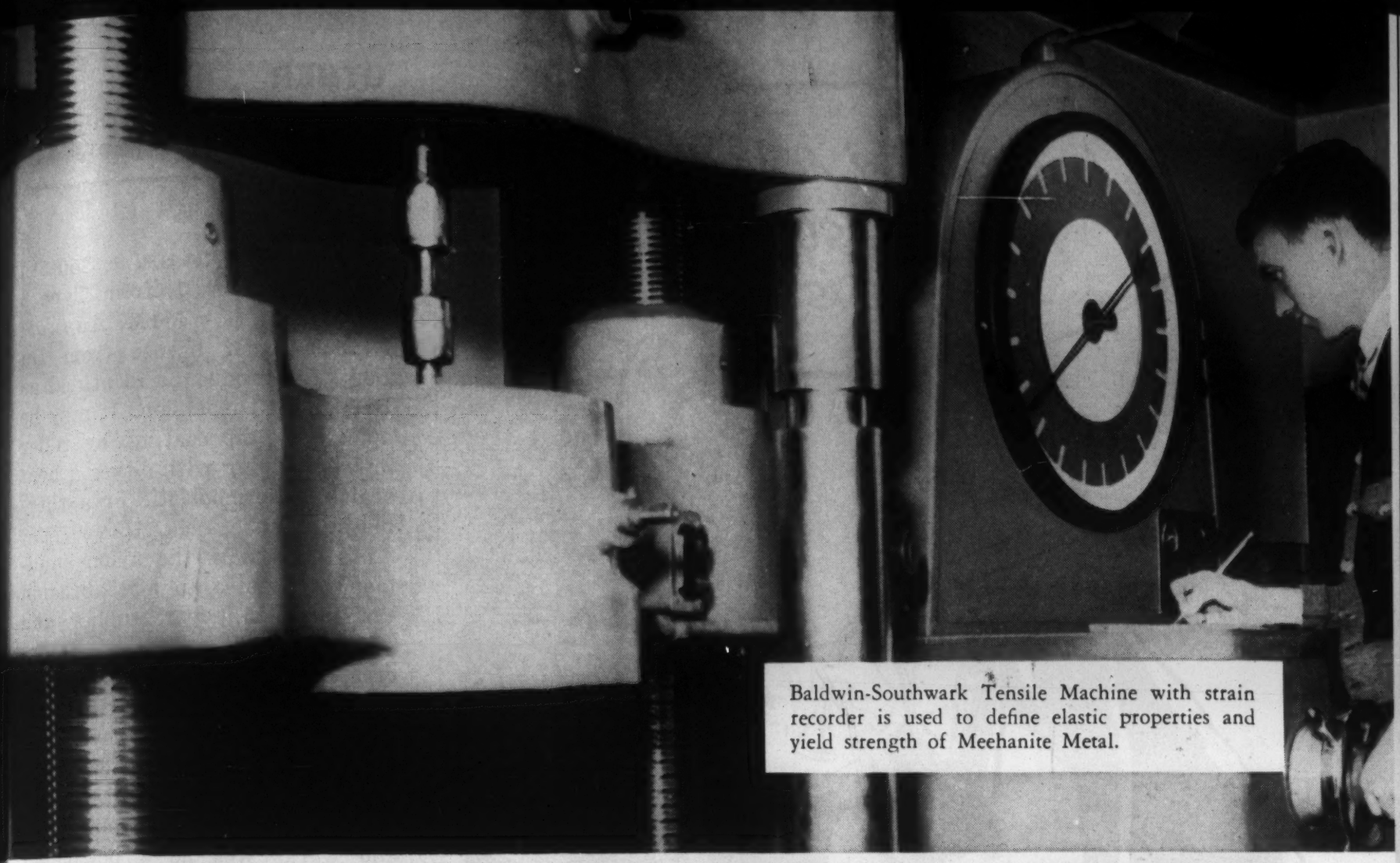
- **"MEEHANITE CASTINGS FOR PRESSURE TIGHTNESS" BULLETIN NO. 43**

Write today to Meehanite Metal Corporation, Dept. 5E, 714 North Avenue, New Rochelle, N. Y.

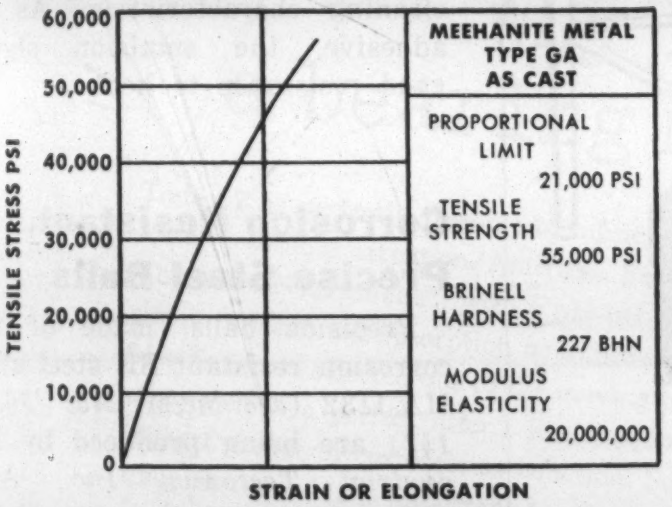
MEEHANITE®

For more information, Circle No. 565



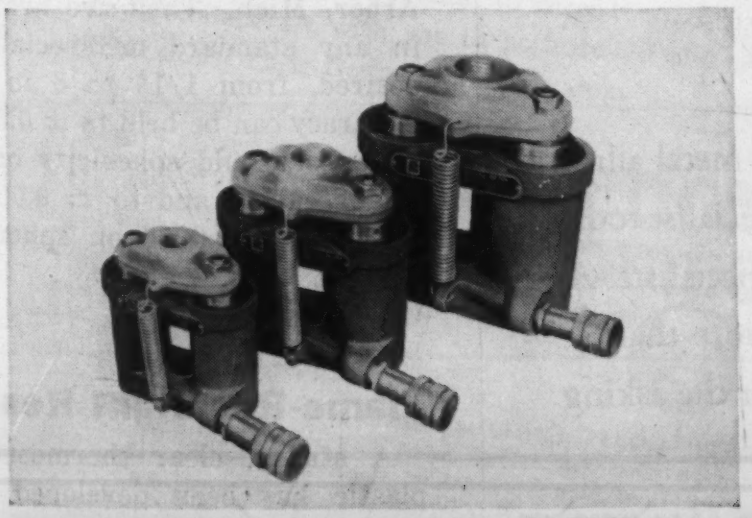
Baldwin-Southwark Tensile Machine with strain recorder is used to define elastic properties and yield strength of Meehanite Metal.

MEEHANITE CASTINGS POSSESS TRUE ELASTIC PROPERTIES AND ARE MADE TO RIGID ENGINEERING SPECIFICATIONS

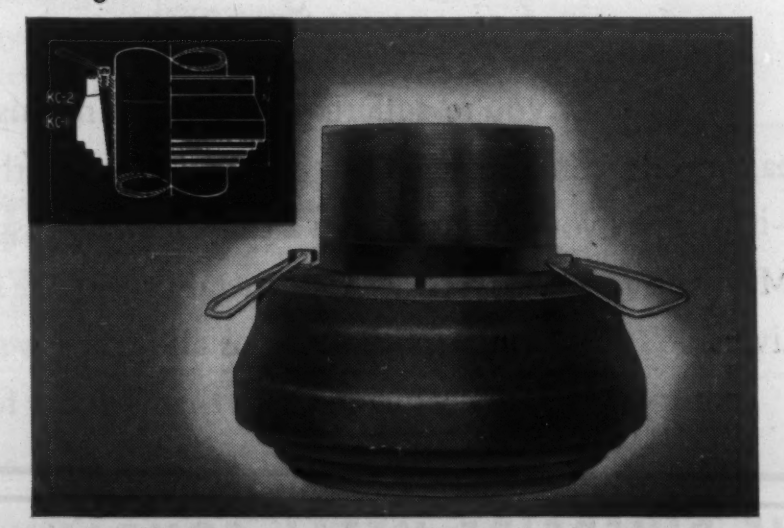


Meehanite Metal has a controlled microstructure, consisting of uniformly distributed graphite in a fully pearlitic matrix, which is comparable to that of a normalized spring or tool steel. This structure, the result of a unique manufacturing process based upon proven metallurgical techniques, assures good tensile properties in association with high yield strength and elastic modulus. These properties are of paramount importance in the selection of engineering materials since they aid in defining the useful characteristics of Meehanite Metal in service.

For information, write today for Bulletin 32 — Physical Properties of Meehanite Castings — and Bulletin 43 — Meehanite Castings for Pressure Tightness.



Power-Twin hydraulic pullers of 17½, 30 and 50 ton capacities manufactured with Meehanite ram body castings tested to 24,000 psi. The 30-ton unit needed an applied load of 87 tons before failure.



Meehanite casting support (KC-1) to hold tapered slips (KC-2) is subjected to downward pressures of up to 150,000 lbs. in oil well drilling. No evidence of failure under loads up to 210,000 lbs.

MEEHANITE METAL®

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If you're suffering from tired metals, weak metals, corroded metals—or some other costly metal ailment—it will pay you well to put in a call to a metals specialist today. May we suggest Riverside? Our metallurgists *are* specialists. And Riverside's experience in non-ferrous alloys spans more than a century. Experience, incidentally, that is yours for the asking.

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OTHER NEW MATERIALS, PRODUCTS

Corticelli Industries, Inc. 350 5th Ave., New York 1, from Type 8 nylon resin (*see* M&M, *Aug '55, p 138*) under license from Du Pont, the product is identified as BCI Nylon Dispersion. It may be applied by dip coating, by roller or by spraying with either a heat sealable thermoplastic or a thermoset finish.

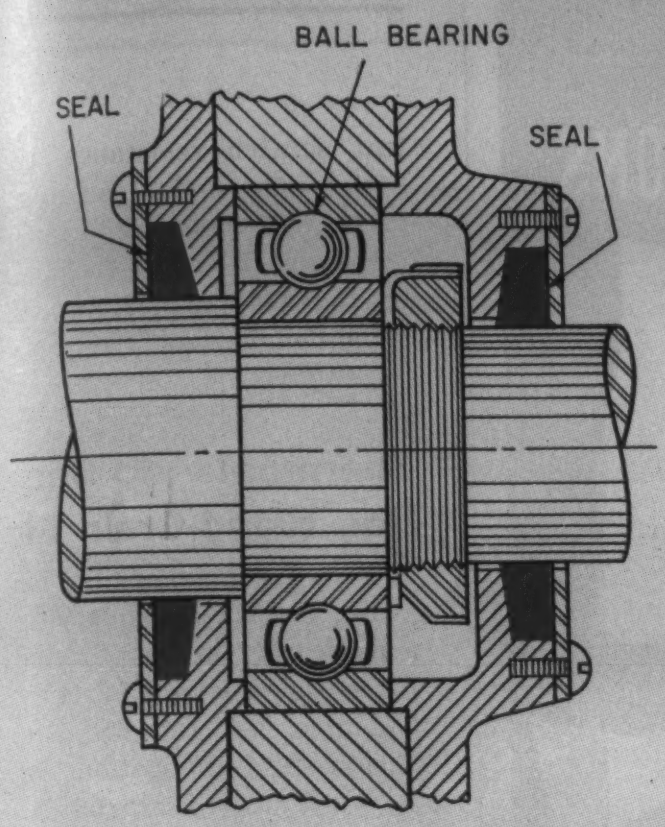
As a coating, the nylon emulsion is claimed to add abrasion resistance to paper, rubber and woven or knited fabrics. It increases both the wet and dry strengths of paper, proving particularly effective for synthetic fiber papers. It also adds vapor permeability characteristics necessary in some packing materials, and works well as a petroleum barrier. The dispersion adds strength and flexibility to nonwoven fabrics and is said to improve their laundering and dry cleaning characteristics. As an adhesive, the emulsion shows good resistance to heat.

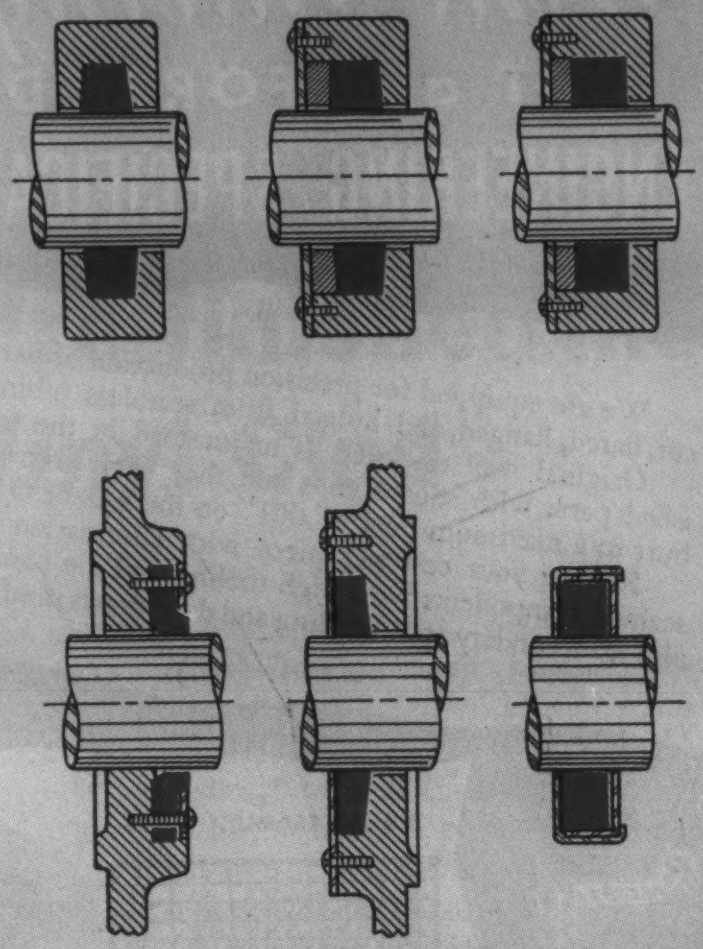
Corrosion Resistant, Precise Steel Balls

Precision balls, made of the corrosion resistant SR steel alloy IIA-1132 (*see* M&M, *Mar '56, p 147*) are being produced by *Industrial Tectonics, Inc.*, Ann Arbor, Mich. They are available in any standard or special size desired, from 1/16 to 6 in. dia. Accuracy can be held to ± 0.00005 in. on size and sphericity on the smaller sizes, and to ± 0.001 on size and ± 0.0005 on sphericity on 6-in. balls.

Flame-Resistant Resin

A strong, clear thermosetting plastic has been developed that chars when direct flame is applied, but does not continue to burn when flame is removed. Called Homalite 101, it is made by *The Homalite Corp.*, Wilmington, Del. It is claimed to have excel-





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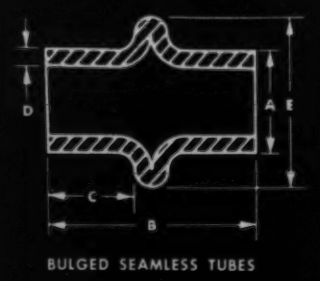
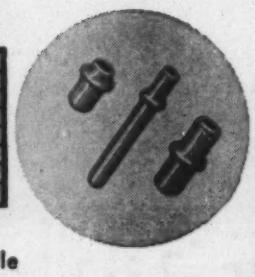


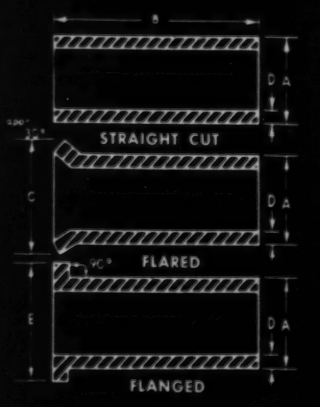
BULGED SEAMLESS TUBES

BULGED SEAMLESS TUBES

A	B	C	D	E
.040	⅛ to ⅜	1/16 to ½	.005	.060
.050	⅛ to ⅜	1/16 to ½	.007	.075
.060	⅛ to ⅜	1/16 to ½	.010	.090
.075	⅛ to ⅜	1/16 to ½	.010	.110
.090	⅛ to ⅜	1/16 to ½	.010	.120
.125	⅛ to ⅜	1/16 to ½	.010	.160
.156	⅛ to ⅜	1/16 to ½	.010	.200

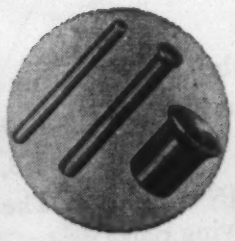


★ Other Dimensions Available

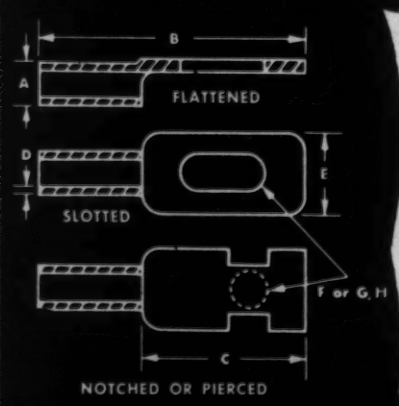


STRAIGHT CUT FLARED FLANGED

A	B	C	D	E
.040	1/16 to 1¼	.050	.005	.055
.050	1/16 to 1¼	.060	.007	.070
.060	1/16 to 1¼	.075	.010	.080
.075	1/16 to 1¼	.090	.010	.100
.090	1/16 to 1¼	.110	.010	.115
.125	1/16 to 1¼	.160	.010	.170
.156	1/16 to 1¼	.185	.010	.200



★ Other Dimensions Available



FLATTENED SLOTTED NOTCHED OR PIERCED

A	B	C	D	E	F	G	H
.040	1/16 to 3/16	.230	.005	.070	.040 x .100	.015 x .075	.040
.050	1/16 to 3/16	.230	.007	.090	.045 x .120	.020 x .075	.060
.060	1/16 to 3/16	.230	.010	.105	.055 x .120	.025 x .090	.062
.075	1/16 to 3/16	.230	.010	.120	.060 x .125	.025 x .090	.075

★ Other Dimensions Available

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OTHER NEW MATERIALS, PRODUCTS

lent scratch resistance, to be a better thermal insulator than glass, to resist crazing and to be insoluble in all solvents. It can be sawed, drilled, bored and machined like metal.

Thermoplastic Sheet Has Wood-Grain Finish

A wood-grain finish is now available in a thermoplastic sheet capable of being formed into three-dimensional parts. It is recommended for displays, toys and similar applications where a low cost wood-grain finish is desirable.

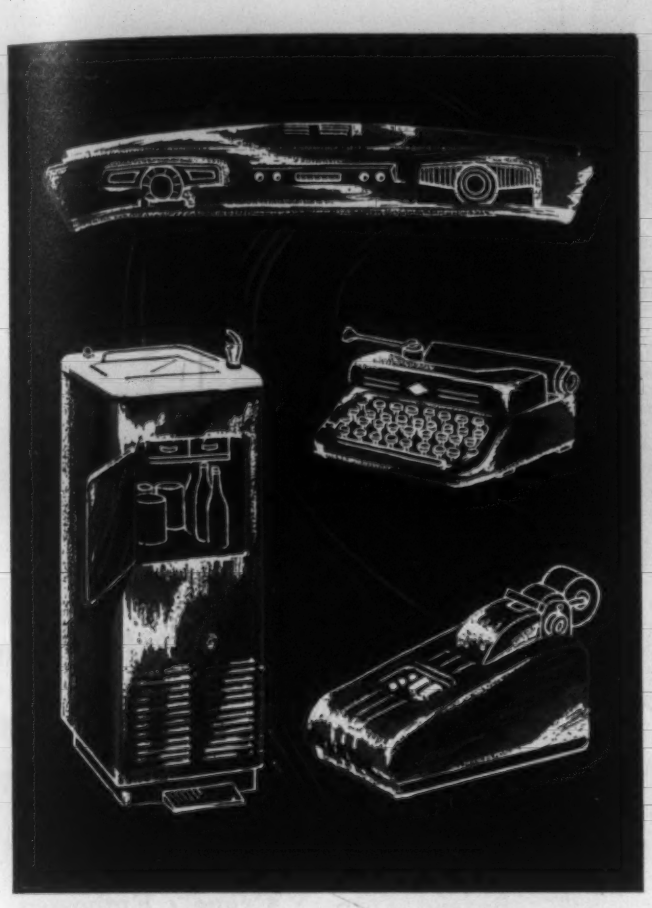
The finish, which comes in blond, mahogany, dark mahogany and driftwood, has been added to Campco, a rubber-modified styrene sheet. According to *Campco Div., Chicago Molded Products Corp.*, 2717 N. Normandy Ave., Chicago 35, the finish is permanent and requires no protective coating.

A wide variety of effects can be obtained by silk screening, by spraying or by applying decals to the finish. By varying transparent colors it is possible to imitate many types of wood and to create an inlaid wood effect.

Material Has Properties of Cloth and Paper

A new material made of kraft paper has many of the characteristics of cloth. It feels like cloth, it is pliable and formable, and it can be sewn and coated. Yet unlike cloth, this new material stretches in every direction and does not ravel. Since it has no warp or woof, it can be slit, die-cut in any shape or fed off rolls into high speed machinery.

Through a patented process, smooth kraft is bound on a drum, creped diagonally, bound again on another drum and cross-creped. Designated X-Crepe, it is made

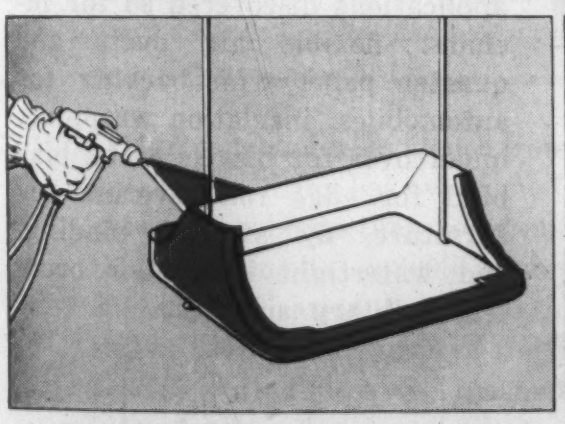


Pre-finished metal... Vinyl Clad

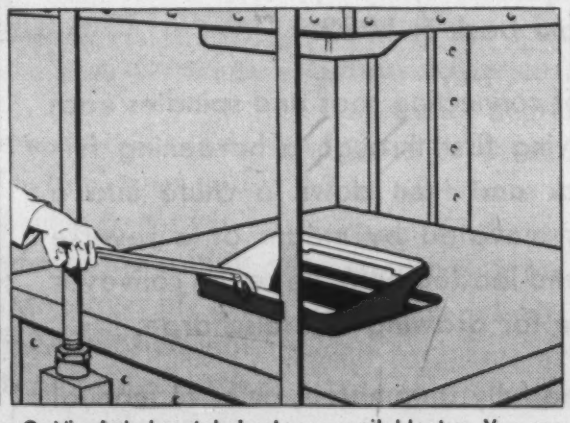
Now—dress up your products—before or during forming—with new vinyl clad metal. Combines appealing vinyl colors and textures with rugged strength of structural metal, eliminates final surface coating. Ideal for business machine housings . . . instrument panels . . . automobile dashboards . . . suitcases . . . commercial water-coolers . . . many other products. Vinyl coating gives sheet metals:

- *New texture, warmth, beauty*
- *Insulation against electricity, heat, cold*
- *Sound-muffling characteristics*
- *New abrasion and scratch resistance*
- *Resistance to acids, solvents, cleaners*

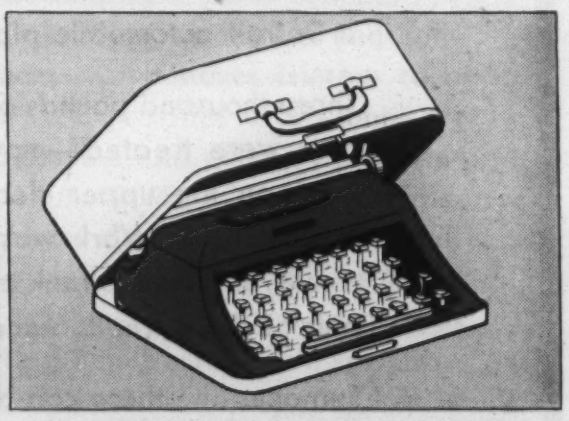
Can vinyl clad metal help you eliminate an expensive alloy . . . or by-pass a costly buffing or hand-polishing operation?



1. Custom processors can spray-coat your preformed metal parts with solution or dispersion vinyls; the spray coating can yield unique decorative effects. Vinyl plastic coating is **already pigmented**... no other finish is necessary...beauty is permanent.



2. Vinyl clad metal **sheets** are available, too. You can pressure-form your parts in your own factory... vinyl coating is flexible, will withstand stamping. Processors can also apply textured embossed surfaces, pressure-form the parts to your specifications.



3. Vinyl clad metal gives your product new sales appeal that bare structural metals or conventional finishes cannot offer... beauty, permanent colors, rust and corrosion resistance.

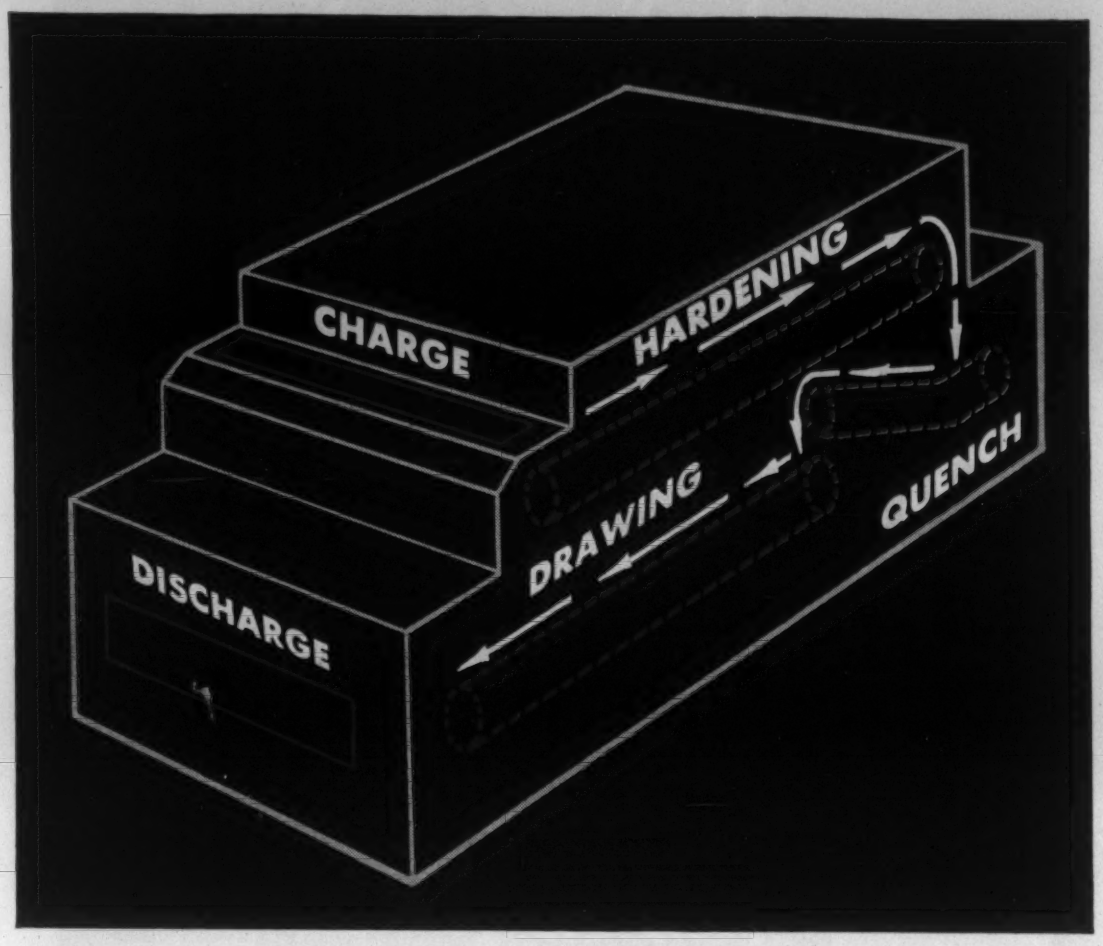
Monsanto does not make vinyl clad metals . . . only the chemical raw materials that go into the vinyl plastics. However, Monsanto would be pleased to put you in contact with custom-processors who can furnish samples, specific information, prices. Send brief description of your needs to: Organic Chemicals Division, MONSANTO CHEMICAL COMPANY, Dept. ID-2, St. Louis, Missouri.

Where Creative Chemistry Works Wonders For You

MONSANTO ®

For more information, turn to Reader Service Card, Circle No. 506

BLAZING THE HEAT TREAT TRAIL WITH HOLCROFT



LET'S TALK ABOUT
DOUBLE DECK FURNACES

Ever try to fit two entirely different furnaces into floor space where only one will go? It can be done. All you do is *stack one on top of the other!*

Holcroft did it first a good many years ago. The furnace illustrated—by no means the first of its type—was built for a Detroit automobile plant back in 1932.

Three thousand pounds of connecting rods and spindles each hour were treated—moving first through a hardening furnace on the upper deck and then down a chute into a quench tank. Work was elevated by means of a reverse conveyor from the tank and loaded onto the return conveyor belt of the lower furnace for drawing and discharge.

Furnaces like these can be fully automated, or have manual transfers. They can be designed to heat treat a specific part, or to be used for general production.

This is the kind of heat treat background and creative engineering that is available to you when you come to Holcroft. It's a good idea to do it—*today!*

HOLCROFT AND COMPANY

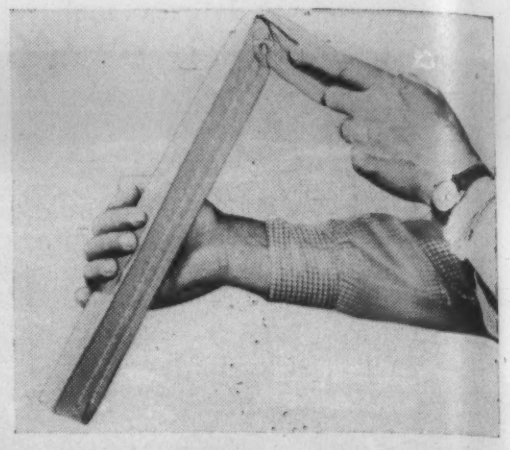
BUILT BY HOLCROFT & COMPANY DETROIT-MICH

6545 EPWORTH BOULEVARD • DETROIT 10, MICHIGAN
PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE

CHICAGO, ILL. • CLEVELAND, OHIO • DARIEN, CONN. • HOUSTON, TEXAS • LOS ANGELES, CALIF. • PHILADELPHIA, PA.
CANADA: Walker Metal Products, Ltd., Windsor, Ontario

For more information, turn to Reader Service Card, Circle No. 559

OTHER NEW MATERIALS, PRODUCTS



***Cloth-like paper** can be used as a base for plastics laminates.*

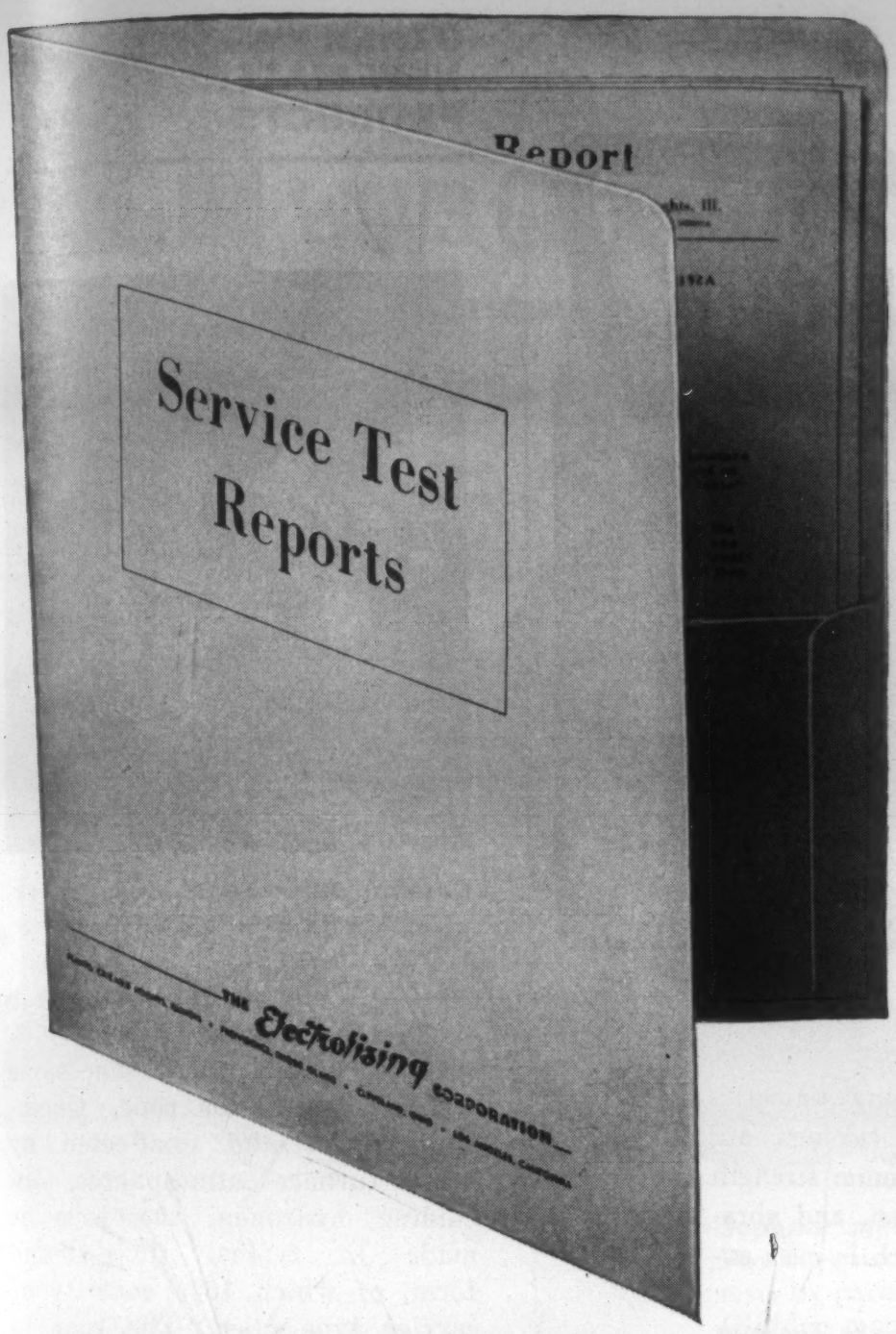
by *Cincinnati Industries, Inc.*, Cincinnati, Ohio. Since it can be laminated to itself or to cloth, fibers, film or foils, it is used as an in-between backing for metal-to-metal, fabric-to-wood and padding-to-fabric construction.

Any pattern or print normally used in embossing can be embossed into X-Crepe. Embossed to produce a cushion effect, it is used as a wrapping for delicate parts. The material has also been used as a base for both low-pressure and high-pressure thermosetting resin laminates. Other applications discovered so far include: flexible air ducts and quarter panel trim backing for automobiles, insulation wrapping, undercover for bicycle seats, bias bind for edge roll covering for furniture, fly swatter binding, and watertight liners for overseas military supplies.

Heat Resistant Insulation Rope

A rope insulation, made of an aluminum silicate ceramic fiber, is claimed to resist heat as high as 2300 F, retaining its form and properties. Made of long staple, the rope has good resiliency, providing handling and installation advantages in many high temperature applications. Called Fiberfrax, it is made by *The Carborundum Co.*, Niagara Falls, N. Y.

Because of its light weight—



How Electrolizing Increases Wear Life of Metal Parts 2 to 10 Times . . .

by reducing friction, abrasion, galling and wear

• New Electrolizing Service Test Reports tell how you can *increase the life of metal wear parts 2 to 10 times without a single change in design, materials or manufacturing methods.*

Here is technical evidence from users describing how Electrolizing has overcome friction, wear and abrasion problems that would not yield to conventional treatments—a 300% life increase on a rolling contact application . . . 5 to 10 times longer life for seals . . . the elimination of fretting corrosion and scoring of a stainless steel fuel metering valve...the remarkable endurance of Electrolized piston rods.

A 16-page booklet accompanying this file tells how Electrolizing accomplishes these benefits . . . how it imparts high hardness to ferrous and nonferrous wear surfaces . . . reduces friction to a remarkable degree . . . provides exceptional resistance to wear, abrasion and galling . . . maintains tolerances within .000025" . . . without distortion or other adverse change in the base metal.

Send today for your free copy of this informative material—it contains a practical answer to your problems with difficult service life specifications or premature failure of wear parts. Fill in and mail the convenient coupon for a prompt reply.

THE Electrolizing CORPORATION

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Cleveland, Ohio 1325 E. 152nd St.
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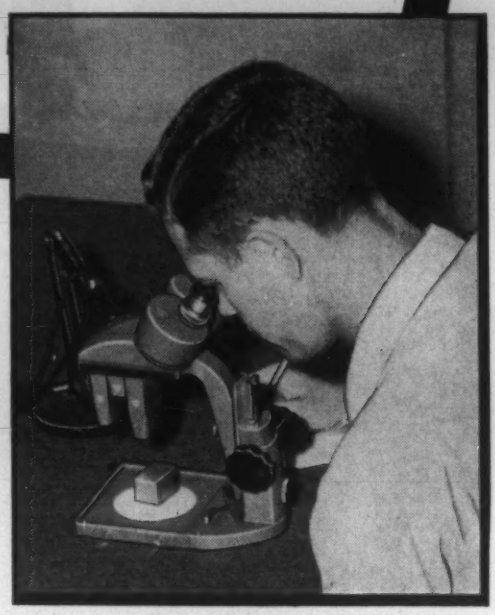
Title.....
Company.....
Street Address.....
City.....Zone...State.....

For more information, turn to Reader Service Card, Circle No. 500

RESEARCH AT WORK FOR YOU

CHIEF SANDUSKY



FERROUS AND NON-FERROUS CENTRIFUGALLY CAST ROLLS, SLEEVES, TUBES, LINERS, CHUTES, RETORTS, RINGS, BUSHINGS, BEARINGS, ETC.

Many concerns are discovering strong uniform, closely grained Sandusky centrifugal castings are essential to applications requiring maximum strength and extreme resistance to heat, corrosion, and abrasion. Chief Sandusky continuous research is ever expanding the range of these uses.

This versatility and quality results from constant research and testing in our modern firm and independent laboratories. Vast foundry and field experience also assists in supplying the proper castings for you.

Excellent machining facilities for drilling, milling, turning and boring are available.

Call or write Sandusky, the leading source of ferrous and non-ferrous centrifugal castings. ALWAYS SPECIFY CHIEF SANDUSKY.

C. M. Lovsted & Co., Seattle, Wash. • Tynes Bros., Birmingham, Ala. • Cordes Bros., San Francisco and Wilmington, Calif.

Chief SANDUSKY CENTRIFUGAL CASTINGS

FERROUS AND NON-FERROUS

SANDUSKY FOUNDRY AND MACHINE CO., Sandusky, Ohio

For more information, turn to Reader Service Card, Circle No. 453

OTHER NEW MATERIALS, PRODUCTS

***Ceramic fiber rope** insulation resists temperatures to 2300 F.*

30 ft of ½-in. dia rope weighs 1 lb —the rope is said to have 50% greater length than the same weight of asbestos rope. Chemically inert and unaffected by most furnace atmospheres, including hydrogen, the rope is made in typical three-strand form, of which 15% consists of carrier type fiber. The rope is easily installed as expansion joint packing and as high temperature wrapping, gasketing and sealing.

Spray Coating Checks Rust

A temporary rust-preventive spray coating for tools, molds, dies, instruments and machinery has been developed by *Eastern Aerosol Products*, Newfoundland, N. J. Known as Rust Chek, it is claimed to offer advantages over oil or grease because it does not absorb dust or rust. A 12-oz aerosol container provides about 80 sq ft of metal surface with a clear, dry waxy film ½ mil thick. The film need not be removed before using equipment, except on precision instruments where critical tolerances must be held. The film works off and in some applications serves as a lubricant.

(More New Materials on p 182)

3 ways Glidden helps you produce better METAL POWDER PARTS

Superior metal powders — Glidden Resistox Metal Powders have been subjected to the most exhaustive tests by parts manufacturers. Result: parts made from Glidden metal powders are judged superior to parts produced from other powders. They permit faster production, with greatly improved finish, appearance and performance characteristics.

Complete field service and lab facilities—Whether you are interested in establishing a new metal powder parts department, or desire to improve operations of an existing department, Glidden can help you. The Glidden metal powders lab and the services of Glidden technicians are available to your metallurgists at any time.

World's largest blender — Glidden can produce up to 30,000 pounds of powder in one batch, more than any other producer... an important factor in complete uniformity of mass-produced parts.

A thorough examination of the manufacturing methods you are now using may lead to substantial savings. Make certain you are not passing up the economies, speedier fabrication and superior parts performance you can get by using Glidden Resistox Metal Powders. Write for complete details.

THE GLIDDEN COMPANY

Chemicals — Pigments — Metals Division

Baltimore, Md. • Collinsville, Ill.
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QUALITY Glidden PRODUCTS — CHEMICALS PIGMENTS METALS

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look to
ESCO for ALLOY
AVAILABILITY

- HASTELLOY B & C
- ALLOY 20
- INCONEL
- MONEL
- PRECIPITATION HARDENING GRADES
- 0.03 MAX. CARBON

YOU GET FAST DELIVERY... even on small orders of special alloys...

Hastelloy B & C, Monel, Inconel, Alloy 20, 0.03 Max. Carbon, Precipitation Hardening Grades are just a few examples of alloys that are available—fast—when you need them. No waiting for long runs of standard production items to be completed before your order can be started. Big orders can be handled efficiently and economically too. A complete metallurgical laboratory enables *ESCO* to take advantage of the latest technological advances. Result: Outstanding quality control on every order.

UNUSUAL SHAPES AND SIZES ARE NO PROBLEM EITHER...

ESCO can supply you with static or centrifugal castings in wall sections and dimensions to meet your most exacting requirement. *ESCO* Shellcast is available, too, where needed.

Ask for details or write for free booklets... "How to cut Costs With *ESCO* Spuncast®"... and "*ESCO* Stainless and High Alloy Products for the Process Industries".

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In Canada, Vancouver, British Columbia and Toronto, Ontario.

For more information, turn to Reader Service Card, Circle No. 617

OTHER NEW MATERIALS, PRODUCTS

Polyester Film, Felt Make New Fabric

A new bonded fabric called MiraFelt consists of Du Pont's Mylar (polyester film) and soft felt. Developed by *The Felters Co.*, 210 South St., Boston 11, the combination fabric is said to have the softness and beauty of felt, and the pliability, strength and durability of polyester films. The Mylar surface is stainproof, resists abrasion, and is easily cleaned or washed. The material is expected to find use in commercial and industrial styling such as automobile and aircraft interiors.

Fluorocarbon Inks for Difficult Surfaces

The problem of marking, striping and printing of nonadhesive and other difficult surfaces is said to have been solved with the development of high temperature-resistant, chemical-resistant fluorocarbon inks. According to *The M. W. Kellogg Co., Chemical Mfg. Div.*, P.O. Box 469, Jersey City 3, N. J., Kel-F printing inks adhere to nylon, fluorocarbon and polyethylene surfaces and can also be used for marking a wide variety of other plastics and rubbers, including rigid and plasticized vinyl.

Available as fully compounded ink concentrates or as a clear vehicle and separate pigment suspensions, the inks can be adjusted in viscosity, drying rate and color strength. The inks are of two types: air drying and heat setting. Both types can be applied by standard printing or marking methods, including rubber stamping, silk screening, offset and rotogravure.

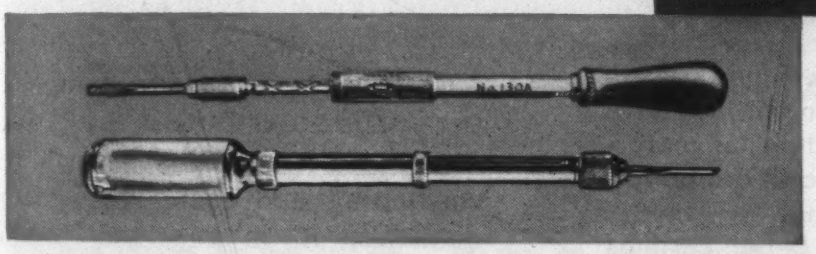
The air-drying series, available in 11 colors and shades, is force dried with hot air or radiant heat for optimum adhesion. Thin film and insulated wire generally require 20-120 sec at 260-300 F.

The heat setting inks, available

Lesson in Low Heat-Hour Cost at "YANKEE" TOOLS

NICHROME* MUFFLES

Stay on the job 4½ Years



Important parts of these famous "YANKEE" Spiral Ratchet Screw Drivers and Automatic Push Drills completely and uniformly hardened for over 9 yrs. in the AGF† reciprocating furnace equipped with long life Nichrome muffles.

"Most important factor in maintaining low heat-hour costs is the extraordinary long life of the cast Nichrome muffles we use in our shaker hearth furnace," says W. W. Peterson, Vice Pres. of Yankee Tools Inc. Div. of Stanley Tools, Philadelphia, Pa., makers of FINE MECHANICS TOOLS.

A variety of small parts are hardened at 1550°-1600° in this furnace, which has been in continuous operation since 1946, on double shifts most of the time. Yet in nine years only two muffles were used — an average life of 4½ years each!

Peterson considers this performance so excellent that Nichrome castings are used throughout the "Yankee" heat treating department in the form of pots for cyanide and lead baths, where their performance is also outstanding. That's why "Yankee" Tools has been a Driver-Harris customer for over 27 years.

Our business is keeping your heat-hour costs *down* to absolute minimum. By specifying D-H alloys — like Yankee Tools — you will get all the benefits of our 32 years of successful experience in doing just that.

*T. M. Reg. U. S. Pat. Off.
†American Gas Furnace Co., Elizabeth, N. J.

Nichrome is manufactured only by

SPECIAL PURPOSE ALLOYS SINCE 1899 — D/H — TRADE MARK REG. U. S. PAT. OFF.

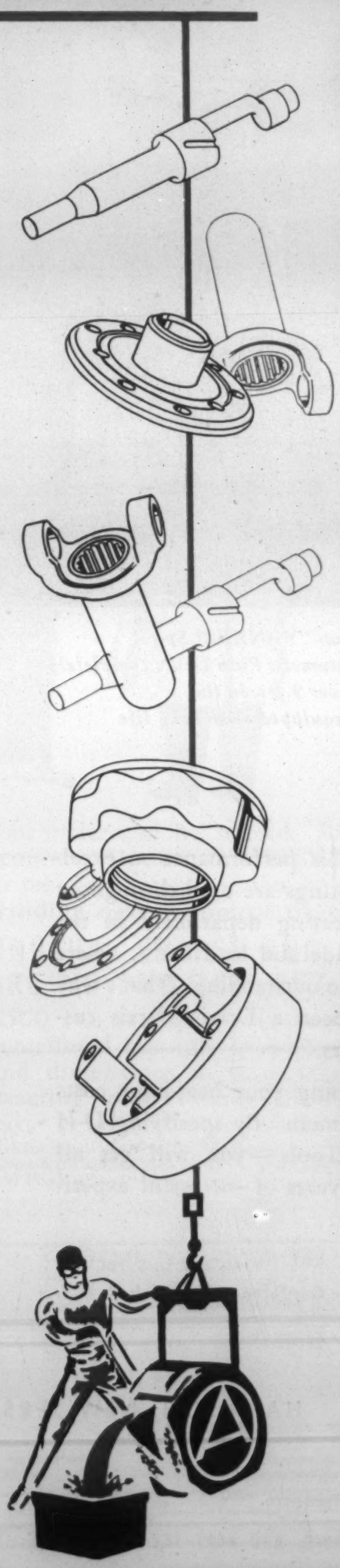
Driver-Harris COMPANY HARRISON, NEW JERSEY

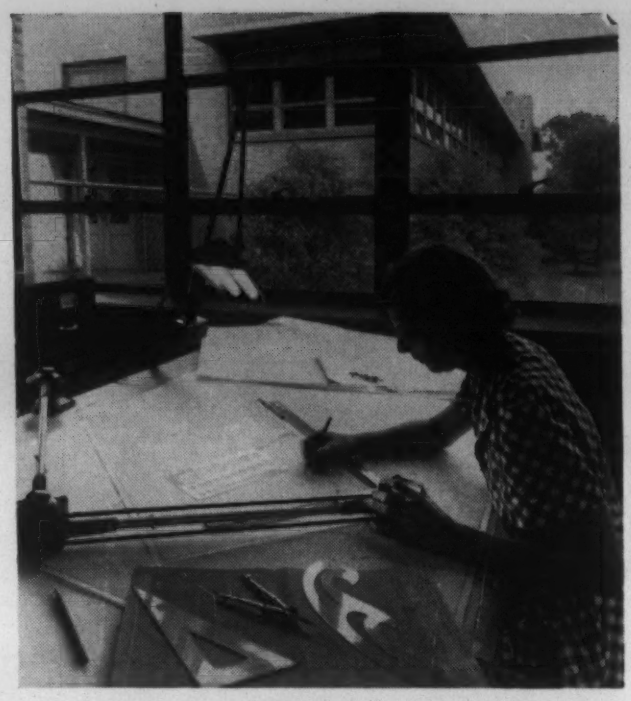
BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco

MAKERS OF WORLD-FAMOUS NICHROME AND OVER 80 ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING FIELDS

For more information, turn to Reader Service Card, Circle No. 533

designed to match your SPECIAL NEEDS



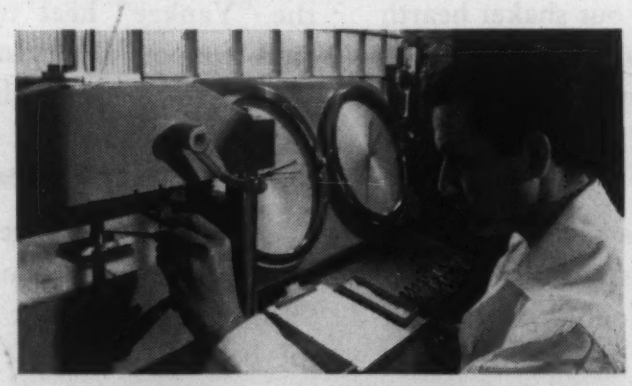


Saving your dollars with good, accurate castings is a 67-year old habit at Albion Malleable Iron Co.

Devising ingenious ways to shorten time between idea and delivery, creation of new designs, engineering new methods for more rapid, economical manufacture and delivery—all are routine benefits you realize when you specify AMICO—the experienced source that guarantees higher quality.

Remember, too, that Albion's ferritic and pearlitic malleable castings offer a new freedom of design, the elimination of excess metal for lower finishing costs. They afford unusually high wear resistance with excellent bearing properties. Also, maximum rigidity, prolonged fatigue life and amazing yield strength. They have a fine uniform grain structure for mirror-smooth finishing qualities and are adaptable to localized hardening.

If you are interested in better castings — why not phone AMICO today — they'll be glad to show you how many ways good, accurate, low-cost casting can save your equipment dollars.



ALBION'S RESEARCH AND DEVELOPMENT LABORATORY—*design engineers and production specialists are ready to help you design better products that can be make at lower cost—without obligation.*

ALBION MALLEABLE IRON CO.

ALBION, MICHIGAN

For more information, turn to Reader Service Card, Circle No. 551

OTHER NEW MATERIALS, PRODUCTS

in five colors, are designed for applications where the inked impression must withstand solvent or chemical attack. They can be cured in a hot air oven, with infra-red radiation, or by direct application of a hot iron. Setting times as low as ½ min have been found practical (hot iron application has been done in 5 sec). The heat setting conductive silver formulation is suitable for printing electronic circuits on plastics film and molded sheet.

Polyurethane Foam

A polyester - isocyanate foam plastic, made by *Hudson Foam Plastics Corp.*, Yonkers, N. Y., is claimed to be six times stronger than foam rubber and to have twice the cushioning effect. Called Cush-n-Foam, it is easily fabricated, flame retardant, and unaffected by ordinary temperatures, climate and most dry cleaning chemicals. Because of its cushioning and sound absorption qualities, it is reported to be finding wide application in the aviation and automotive industries.

Metal-Clad Laminates for Printed Circuits

Two materials, consisting of copper clad to a ceramoplastic and to fluorocarbon plastics, respectively, have been developed for use in printed circuits.

1. Copper-clad ceramoplastic

Designed to withstand temperatures up to 450 F, a copper-clad ceramoplastic for etched printed circuits has been developed by *Mycalex Corp. of America*, Clifton, N. J. Designated Supramica 500, its thermal endurance is limited only by the bonding agent used in the application of the copper.

The material is claimed to have

Anaconda specifies Enjay Butyl rubber

TO DEFY OZONE IN HIGH-VOLTAGE CABLES...

for more current per circuit...more power per dollar

Anaconda specifies Enjay Butyl insulation for high-voltage cables because this rubber has incredible resistance to ozone. Surpassing the industry's standard three-hour specification test, Enjay Butyl insulation used by Anaconda showed *no injury after 72 hours* of ozone concentration tests—24 times longer than specification requirements. Other rubbers would deteriorate and crack in a fraction of this time.

With the help of Enjay Butyl, millions of feet of Anaconda's cable now in use deliver more current per circuit, more power per dollar.

Perhaps *your* product, too, can be improved with versatile Enjay Butyl. It comes in non-staining grades for white and light-colored parts, offers excellent electrical properties, low price and *immediate availability*. For full information, contact the Enjay Company. Complete laboratory facilities and technical assistance are at your service.

ENJAY BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

ENJAY *Pioneer in Petrochemicals*

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Other offices: Akron • Boston • Chicago • Los Angeles • Tulsa

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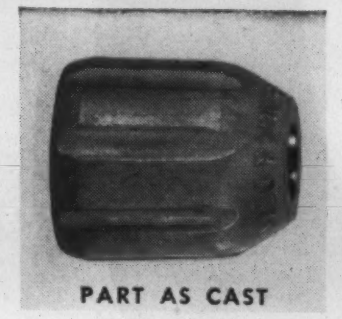
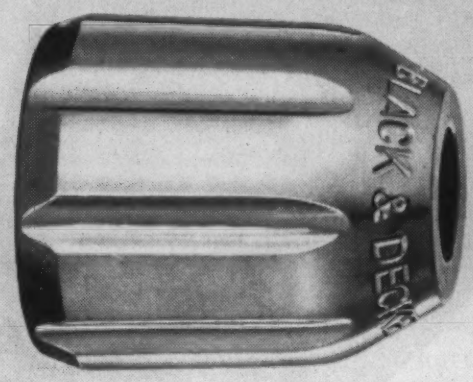
now

you can get this brilliant finish directly on zinc die castings!



PART AS CAST

No electroplating--no mechanical finishing!



TREATED WITH NEW IRIDITE

NEW IRIDITE® (Cast-Zinc-Brite)

brightens zinc die castings by chemical polishing, protects against corrosion

NOW, FOR THE FIRST TIME you can get a brilliant, decorative finish directly on zinc die-cast parts . . . without mechanical finishing, without electroplating! The luster is provided by the *chemical polishing* action of new Iridite (Cast-Zinc-Brite) solution. Even surface blemishes, such as cold shuts, are brightened by this new process. No electrolysis. No special equipment. No specially trained personnel. Just a simple chemical dip for a few seconds and the job is done. And, this new Iridite has been *tested and proved* in production.

CORROSION RESISTANCE, TOO! New Iridite (Cast-Zinc-Brite) provides exceptional corrosion resistance for bright-type chromate finishes . . . also guards against blueing or darkening by eliminating zinc plate formerly required in bright chromate finishing of zinc die castings.

AS A BASE FOR ELECTROPLATING—Lower mechanical finishing costs are possible where plated finishes are *required* since the brightness provided by this new Iridite may be sufficient.

LET US SHOW YOU what Iridite (Cast-Zinc-Brite) can do for you. Send us at least a half-dozen typical zinc die-cast parts for FREE PROCESSING for your own tests and evaluation. Or, for immediate information, call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified 'phone book. *IMPORTANT: when you give us samples for test processing, please be sure to identify the alloy used.*

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals; ARP Plating Chemicals

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OTHER NEW MATERIALS, PRODUCTS

absolute age and dimensional stability, even under adverse conditions of storage or use. It is therefore desirable for circuits in which any small warpage might introduce variable contact resistance or changes in capacity or inductance. Because of these characteristics and its good, low-loss electrical qualities, the material is expected to find use in etched circuits for guided missile, oil field and aircraft applications.

2. Copper-clad fluorocarbon

Recommended for use under severe temperature, moisture and electrical conditions, a laminate consisting of 1- or 2-oz copper foil and a fluorocarbon plastic has been developed for printed circuits use by *International Resistance Co.*, 401 N. Broad St., Phila. The laminate is said to be the result of a new bonding process for joining copper to the inherently nonadherent polymer, monochlorotrifluoroethylene (such as Kel-F, Polyfluoron or Fluorothene). The resulting laminate, in which no resin adhesive is used, features minimum cold flow, zero water absorption, excellent machinability and a water repellent surface. The resin is unaffected by acids, alkalies or common organic solvents.

The laminate will withstand intermittent exposure to temperatures up to 375 F and continuous exposure to temperatures up to 300 F. Bond strengths are said to range from 8 to 10 lb per in. After a 10-sec dip in solder at 460 F, no blistering or delamination occurs in circuit lines 1/32 in. wide. After 30 hr in boiling water, no measurable water absorption, delamination or effect on electrical properties is found.

At present, laminates are available in sizes up to 10 in. square. Standard base thicknesses are ⅛ and 1/16 in., though bases as thin as 0.002 in. are available on special order.

(More New Materials on p 188)

International Products & Mfg. Co.

switched to La Salle **fatigue-proof** STEEL BARS

TO MAINTAIN UNIFORMLY HIGH QUALITY

International Products & Manufacturing Company is now specifying "FATIGUE-PROOF" steel bars for generator and starter shafts. These are heavy-duty shafts. Formerly they used 4140 or 8640 heat-treated.

Field failures can be anticipated unless the finest of materials and the best of manufacturing practice are employed.

"FATIGUE-PROOF," by eliminating heat-treatment, does away with any possibility of quench cracked shafts getting past inspection. Since no straightening after heat-treatment is required, unfavorable residual stress due to severe straightening operations cannot be present.

It's another case where "FATIGUE-PROOF's" high strength in-the-bar eliminates a possible cause of trouble.

If you want to improve the quality of your products and avoid the problems of machining or heat-treating parts from high strength carbon or alloy steels . . try a sample bar of "FATIGUE-PROOF." If you will give us application details, send a blueprint, or call La Salle Sales Engineer at REgent 4-7800, Chicago, Illinois, he will send you a test sample if it appears "FATIGUE-PROOF" can be used to your advantage.

International Products & Manufacturing Co., of Chicago, are manufacturers of automotive starter and generator parts.

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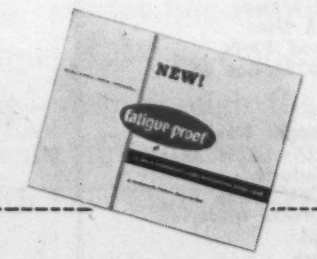

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OTHER NEW MATERIALS, PRODUCTS

***Alumina refractory** provides insulation at temperatures up to 3300 F.*

Castable Refractory

A refractory insulating castable is said to give trouble-free protection to cast furnaces and kiln parts. Lightweight and monolithic, it consists of about 96% aluminum oxide and has a density of 100 lb per cu ft. With a maximum usable hot face temperature up to 3300 F, it appears suitable for back-up insulation for kilns and furnaces, back-up for pit furnace linings, high temperature burner ports, and insulation for chemical furnaces.

According to *Norton Co., Refractories Div.*, Worcester 6, Mass., anyone familiar with cements and their applications can use Alundum 33-1 without difficulty. It takes 1 hr to stiffen, 4 hr for an initial set and 18-24 hr for the final set.

Inserts, Electrodes, Other Joining Materials

Following is a roundup of recent developments in materials for welding and soldering.

1. Steel insert rings

Inert-gas tungsten-arc welding of piping without backing rings can be achieved with solid insert rings available from *Grinnell Co., Inc., Industrial Piping Div.*, Providence, R. I.

On piping of wall thickness over ¼ in., the Grinnell welding insert ring is said to help produce root pass welds of uniform and smooth contours, free of crater

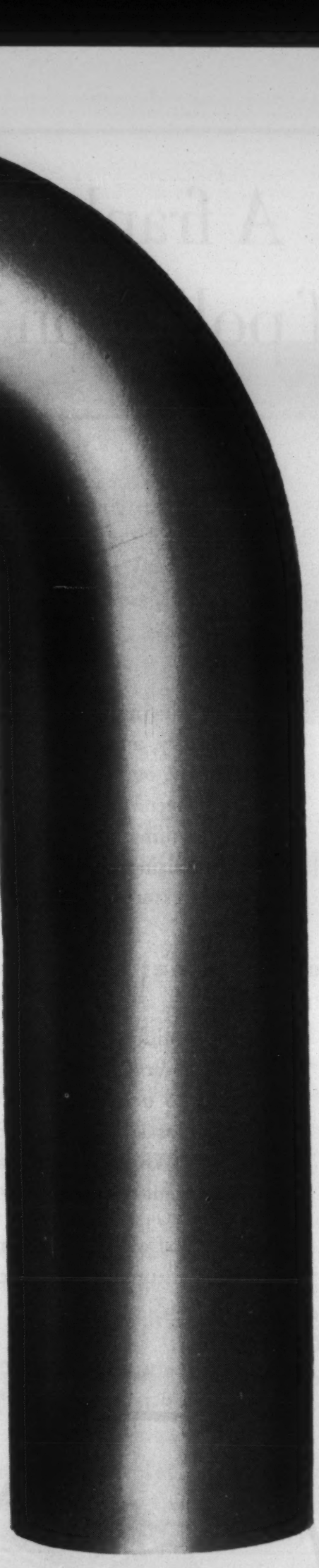
Contour-Weld tubing used for an annealing furnace application. Photo courtesy of Westinghouse Furnace Division, Meadville, Pennsylvania.

new CONTOUR-WELD **stainless tubing**

takes bends like these in stride...

Here's dramatic proof of the soundness of the weld in Trent's new *Contour-Weld** pipe and tubing. Bent on an extreme 3¼" center line radius, this 3" O.D. x .083 wall sample shows no evidence of failure in the weld area – even though the weld is on the outside of the bend. It's just one example of what you can do with new *Contour-Weld.*

If your application calls for bent pipe or tubing, you can use *Contour-Weld* with confidence. You'll like its uniformity in wall thickness and curvature . . . its corrosion resistance . . . its superior performance. Try *Contour-Weld* stainless pipe or tubing on your next job—you can't buy better.



Bending done by Johann Tube Bending Company, Milwaukee, Wisconsin.

*Contour-Weld is the trade mark of the Trent Tube Company for its process of welding pipe and tubing which is protected under U.S. Patent 2,716,692.

TRENTWELD **STAINLESS STEEL TUBING**

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

For more information, turn to Reader Service Card, Circle No. 522

A frank statement of policy on extrusions

"Ever since this company was founded, we have put *quality first* in the manufacture of aluminum extrusions. Until now, we have also been able to match—and often surpass—any source for speed of delivery and service.

Even though we are increasing capacity, our products are enjoying the heaviest demand in the company's history, and frankly our schedules are loaded. Momentarily, our deliveries are not quite as fast as they have been, or as we would like them. We are doing everything we can to speed up service, short of compromising quality and workmanship. But, despite the pressures—

Wells will not sacrifice quality for speed.

Please continue to send us your orders—we are in business to serve you. Though it may take a little more time to deliver than usual, we will give each order our closest attention and complete it as quickly as possible. Why not anticipate a little—and order *ahead* of urgent needs.

Quality first will remain our policy—our promise. It is your assurance that every Wells job is a job *well done.*"

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SALES MANAGER

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North Liberty, Indiana

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OTHER NEW MATERIALS, PRODUCTS

***Insert ring** with positioner pins.*

and centerline cracks. The completed root pass weld provides an effective back-up for subsequent shielded metal-arc welding with covered electrodes.

On thin-wall piping, such as Schedule 5 and 10 stainless steel, the welding insert ring improves weld contour. On many sizes the insert ring also eliminates the need for separately supplied filler metal, as well as the necessity for one or two additional weld passes.

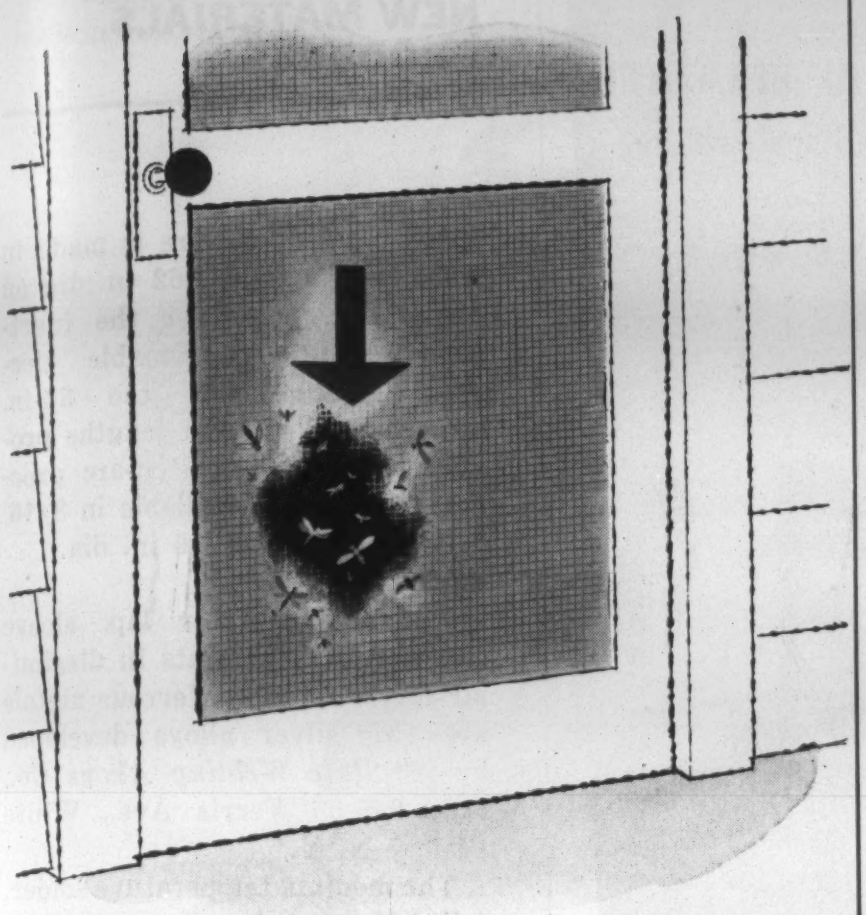
These consumable solid insert rings are produced for all standard or special pipe and tube sizes of 1½ in. dia or larger. Insert ring materials include: mild steel; alloy steels 1.25 Cr-0.5 Mo, 2.25 Cr-1.0 Mo, and 5.0 Cr-0.5% Mo; and stainless steels 304, 304 ELC, 310, 316, 316 ELC, and 347 (either fully austenitic or containing 4-6% ferrite).

2. Electrode, filler wire

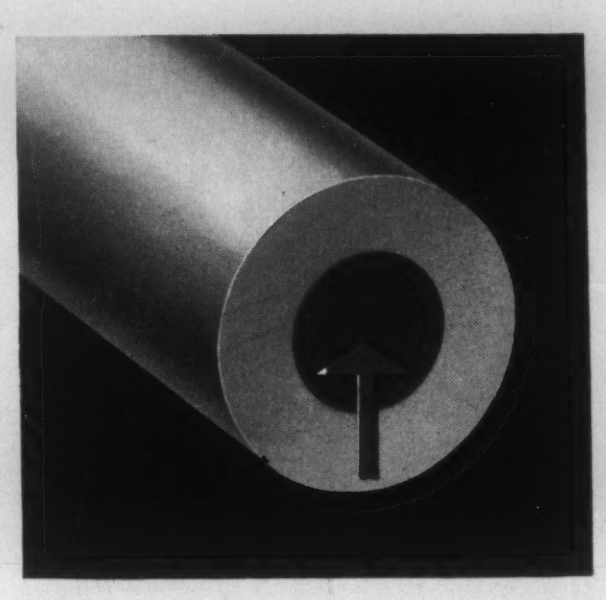
Two new welding products have been developed by *International Nickel Co.*, 67 Wall St., New York 5, for welding Ni-o-nel, a nickel-iron-chromium alloy used in equipment for sulfuric acid pickling. The products are 135 Ni-o-nel electrode and 65 Ni-o-nel filler wire and rod.

Both the electrode and the filler wire are said to provide x-ray quality welds and to allow operation in all positions. Resulting welds have corrosion resistance and strength equal to that of the base metal itself.

The 135 Ni-o-nel electrodes are 14 in. long and available in 3/32, 1/8, 5/32 and 3/16 in. dia. The



a hole here is a nuisance...



a hole here is convenient

Crucible Hollow Tool Steels eliminate the nuisance of drilling, boring, cutting-off or rough-facing of ring-shaped, tubular or bored tool steel parts. They save you money, too, by reducing machine time and scrap losses.

Crucible Hollow Tool Steels are produced in all of the famous Crucible tool steel grades . . . in bars or saw cut lengths to meet your needs. And they're available in almost any combination of O.D. and I.D. sizes. You can get these five grades "off the shelf" from your local Crucible warehouse: KETOS oil-hardening . . . SANDERSON water-hardening . . . AIRDI 150 high-carbon, high-chromium . . . AIRKOOL air-hardening . . . NU DIE V hot work.

See how Crucible Hollow Tool Steel Bars will save you hours of shop time. Call your Crucible representative. *Crucible Steel Company of America, The Oliver Bldg., Mellon Square, Pittsburgh 22, Pa.*

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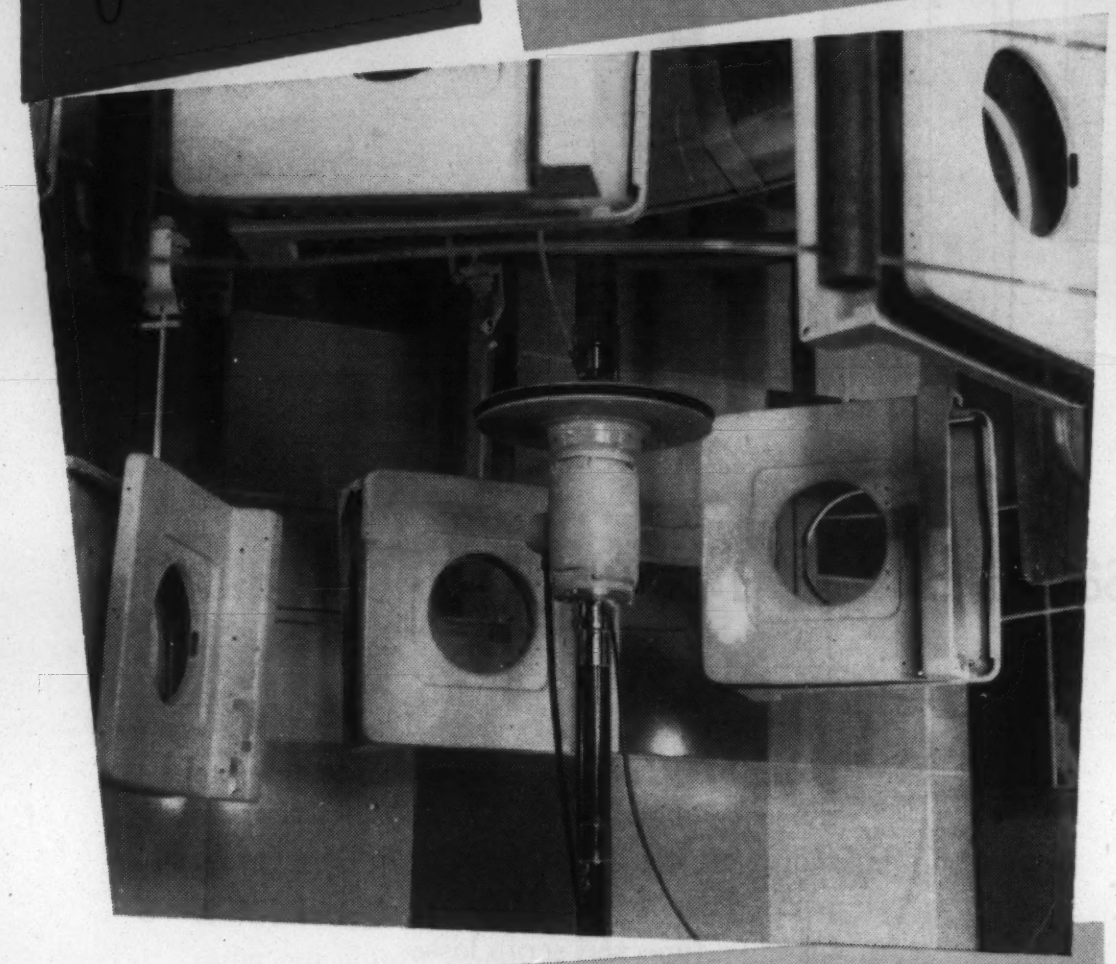

General Electric—an extensive user of Ransburg Electro-Spray for painting with synthetic enamels—is the first to use Ransburg No. 2 Process in the application of porcelain enamel.

GE—less than a year in electrostatic production—now is processing almost a million square feet of cover coat each month in the General Electric Home Laundry finishing department at Appliance Park.

DRYER TOPS AND WASHER COVERS ARE BEING COATED ELECTROSTATICALLY WITH THESE SPECTACULAR RESULTS

Quality of appearance and chip resistance are greatly improved with all colors: white, yellow, pink, turquoise, blue and brown.

About 97% of the atomized enamel is deposited on the washer and dryer parts.

Because of improved uniformity in coating thickness, weight of applied enamel was substantially reduced.

Because of lower application weight, the few rejected parts can be re-processed more times before being scrapped. This reduces the ultimate scrap rate by at least 95% of that previously expected.

Efficiency, measured by the amount of good ware, averages above 90%.

Want your products tested?

Ransburg has fully equipped laboratory facilities including reciprocating disks, helical conveyors, stationary disks, and the latest advancements in equipment for applying porcelain enamel with the No. 2 Electrostatic Spray Process. Manufacturers are invited to send sample products to our Indianapolis laboratories for tests and demonstrations to prove for you the advantages and benefits of electrostatic spray application of porcelain enamels.

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For more information, turn to Reader Service Card, Circle No. 401

OTHER NEW MATERIALS, PRODUCTS

65 Ni-o-nel filler wire is made in 0.035, 0.045 and 0.062 in. dia on disposable spools for the inert-gas welding, consumable electrode process. In the 36-in. straightened and cut lengths produced for the tungsten-arc process, the wire is available in 3/16, 5/32, 1/8, 3/32, 1/16 in. dia.

3. Silver solders

Recommended for lap, sleeve and socket-type joints in dissimilar ferrous and nonferrous metals are two silver alloys developed by *All-State Welding Alloys Co., Inc.*, 249-55 Ferris Ave., White Plains, N. Y.

The medium temperature solder, called No. 105, is a low cost silver alloy that melts at 675 F, flows freely at 750 F, and has a shear strength of 18,000 psi. The other alloy, No. 107, is a general purpose solder for aluminum and other metals. Said to have excellent corrosion resistance, it has a 20,000 psi shear strength, melts at 450 F and flows at 600 F.

Both alloys require a special flux, the residue from which should be washed off with warm water. Wire diameters are 1/16, 3/32 and 1/8 in.

4. Non-corrosive flux

Use of a new soldering flux is said to eliminate need for expensive washing and buffing operations to remove flux residues after soldering. Marketed by *Hi-Grade Alloy Corp.*, 1236 S. Talman St., Chicago 8, Hi-Grade No. 29 is claimed to decompose completely during soldering of copper and copper alloys.

Hardfacing Powders

Nickel base alloy powders for hardfacing have been developed by *Western Carbide Corp., subsidiary of Superweld Corp.*, North Hollywood, Calif. They can be sprayed with various types of guns and applied to practically all metals with melting points above 1850 F. Called Hi-C spray pow-

Versatile

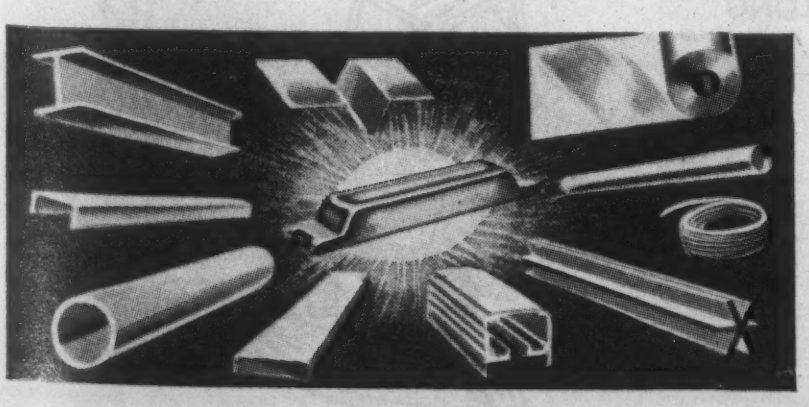
One of nature's most versatile creatures is the platypus, found in Australia.

This curious creature has the bill and broad webbed feet of a duck. It lays eggs that resemble the eggs of a reptile. The male can secrete a poison which is similar to that produced by a venomous snake. The body of the platypus is covered with fur as thick as that of an otter. It digs a den with a tunnel entrance under water and an air shaft on land. The platypus swims like a fish, yet suckles its young like a mammal.

One of industry's most versatile materials is aluminum. At an accelerating pace, industry is developing new fabricating methods for aluminum—methods never before used with structural metals. These new methods are being applied to economically fabricate products embodying aluminum's advantageous and versatile characteristics.

Today we have inexpensive aluminum collapsible tubes, light corrosion-resistant construction materials, low-resistance electrical conductors. Tomorrow, today's new fabricating techniques will provide rigid aluminum containers, more aluminum in transportation, in electrical equipment and in a multitude of other products.

Aluminium Limited Sales, Inc. is the distributor in the United States for aluminum from Canada. Why not investigate making your products of aluminum?



Versatile

In the form of sheet, plate, tube, rod, pipe, wire, bar, extruded shapes, architectural and structural sections—aluminum is growing faster in number of uses than any other metal.

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bright nickel plating process

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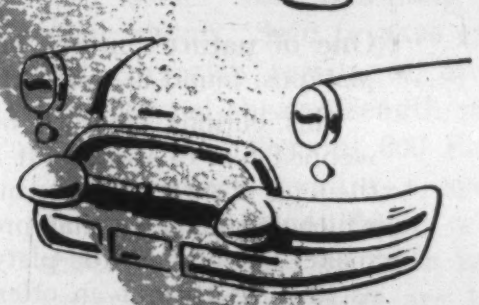
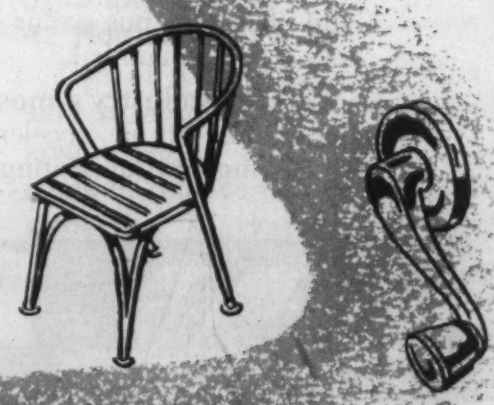
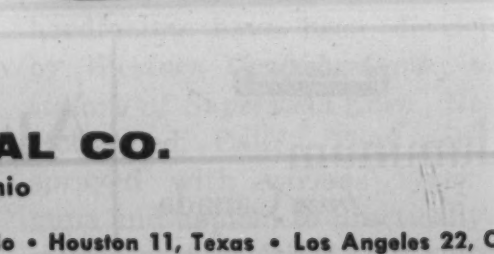
For additional information contact the Harshaw office nearest you.







THE HARSHAW CHEMICAL CO.
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For more information, turn to Reader Service Card, Circle No. 434

OTHER NEW MATERIALS, PRODUCTS

ders, they are available in formulations that provide Rockwell C hardnesses of 40, 50 and 60.

The hardfacing consists of a hard, corrosion resistant matrix in which are embedded extremely hard chromium boride particles. More than 80% of initial hardness is retained at 1000 F, and about 70% at 1400 F. Oxidation resistance is also said to be good for long periods at temperatures up to 1800 F. Fused surfaces may be hot-forged and the sprayed and fused surface ground to a mirror-like surface with a low coefficient of friction.

Chemical, Electrical and Decorative Tapes

Four new tapes include a pressure-sensitive Teflon tape for process equipment, a solvent-activated tape for exterior decals, a wood veneer tape for finishing plywood edges, and an ozone-resistant tape for cable splicing.

1. Pressure-sensitive Teflon

By means of a new priming treatment, *Minnesota Mining & Mfg. Co.*, Dept. J6-61, 900 Fauquier St., St. Paul, Minn., has been able to anchor a pressure-sensitive silicone adhesive to a Teflon backing. The result is a pressure-sensitive tape said to offer excellent chemical protection and easy release properties over a wide temperature range.

Called Teflon tape No. 549, it combines all the properties of a high quality Teflon film with the chemical and heat resistance properties of the silicone adhesive. Although the tape is expected to be useful for chemical process equipment in general, its adhesive quality should make it particularly suitable for food processing equipment.

The tape, made in both 3½ and 6½-mil thicknesses, consists of 2- and 5-mil films coated with 1½

For more information, Circle No. 447 ➤

Spincraft did it for Gulf Oil...

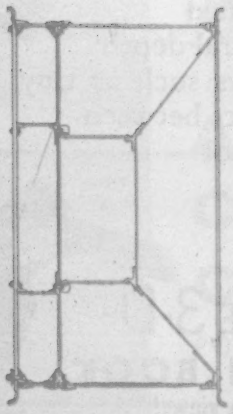
Spincraft can do it for you!

"Marsh Buggy" travels over rugged terrain on spun aluminum wheels

another example of spinning and fabrication by Spincraft

13 DIFFERENT OPERATIONS

The "Marsh Buggy" rolls on sturdy, lightweight aluminum wheels — spun and fabricated by Spincraft. Even if all four balloon tires fail, the spun aluminum air-tight wheel drums will keep the vehicle afloat. Wheel flange segments, extensions, .118" thick 52SO aluminum stiffener ribs, No. 11 U. S. gauge (.125" thick) stainless steel front hub cones were machined and assembled to complete the wheels. In addition to spinning, Spincraft performed the following operations: welding, grinding, polishing, machining, punching, braking, drilling, tapping, sawing, riveting, assembly and testing.



Write for Spincraft data book. If you have a specific problem, tell us about it — no obligation.

WHEN Gulf Research & Development Co., a division of Gulf Oil Corp., contracted to build their world-famous "Marsh Buggy" for the U. S. Army, Gulf called on Spincraft to fabricate all four wheel assemblies.

These huge wheels are designed to bear loads of 1,500 to 4,000 lbs. Combining strength with lightweight, these tough aluminum alloy wheels can take grueling cross-country punishment. The 10-ft. dia. tires easily negotiate swamp, water, sand, deep mire and other difficult terrain, at speeds from ¼ to 40 miles per hour.

This is another example of Spincraft's versatility and manufacturing skill. Complete facilities are available for all types of contract manufacture — finished parts, assemblies and complete products. Take advantage of our modern tools for spinning and fabricating. They can pay off in savings for you, too.

WORKSHOP OF AMERICAN INDUSTRY SINCE 1919

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How *REMINGTON RAND* uses 3-D Micro-Vision to maintain peak shaver production

Remington Rand has solved the problem of critical inspection with Bausch & Lomb Stereomicroscopes. And it's done with an increase in production. Clear, sharp, magnified views of shaver head—with natural depth perception—quickly reveal flaws such as tiny cracks, bent blades, burrs, contact between cutter and head. Increased operator comfort, higher efficiency, keep peak production rolling.

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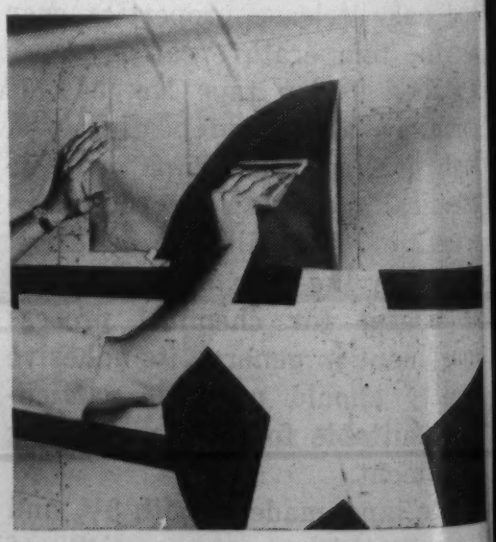
OTHER NEW MATERIALS, PRODUCTS

mils of silicone adhesive. The 3½-mil tape features 200% elongation and a tensile strength of 25 lb/in. of tape width, while the 6½-mil tape offers 150% elongation and 40 lb/in. tensile. Both tapes, 3M explains, can be used continuously at temperatures ranging from —65 to 400 F (up to 457 F intermittently) and offer excellent conformability at all times.

Laboratory tests of the tape's chemical resistance revealed no significant effect on taped glass panels after seven days' immersion in distilled water, 3% sulfuric acid, 30% sulfuric acid, 10% sodium chloride or 1% sodium hydroxide. The tape was applied to a portion of steel plate and immersed in a 10% hydrochloric acid for ten days. Upon removal of the tape there was no evidence of corrosion on the taped portion, while the unprotected area was thoroughly pitted by acid action.

2. Solvent-activated vinyl

A plastic film with a solvent-activated adhesive has been developed by *Permacel Tape Corp.*, New Brunswick, N. J., primarily for use as an exterior marking medium for aircraft. Designated 196 Plastic Film, it is said to be oil resistant, flame resistant (self-extinguishing), pinhole-free and dimensionally stable. It is composed of a 2½ mil vinyl film with



***Plastics film** designed for aircraft marking.*

For more information, Circle No. 391

'dag' dispersions . . . *a touch does so much!*

Colloidal Graphite saves $25,000 a year on jet-blade forging

In the close-limit forging of a jet-turbine blade, a prominent manufacturer found that by using **'dag'** Colloidal Graphite on the dies, only one blow was needed to go from upset billet to final blade shape. Besides eliminating the second hammer-blow previously required, intermediate descaling and reheating operations were also avoided . . . for a total yearly saving of some $25,000 on this single operation.

Both oil-based and water-based **'dag'** Colloidal Graphite dispersions are widely used in forging operations. Diluted and sprayed on the dies, the colloidal graphite forms a slick lubricating film . . . protects the expensive dies and improves metal flow during forging.

Pretreatment of new dies with **'Aquadag'** — colloidal graphite dispersed in water — has paid off handsomely, too. Some firms estimate a 50% greater usable life from forging dies given this protective film of colloidal graphite before being put into service.

The benefits of **'dag'** dispersions for forging and other metalworking applications are discussed in Bulletin 426. Ask for your free copy.

100th Anniversary

1891—SILICON CARBIDE
1895—SYNTHETIC GRAPHITE
1906—COLLOIDAL GRAPHITE

ACHESON COLLOIDS COMPANY

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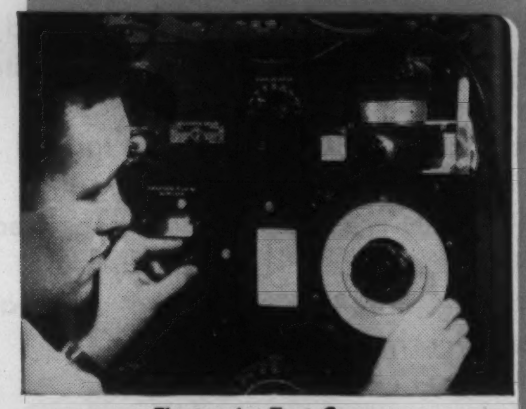
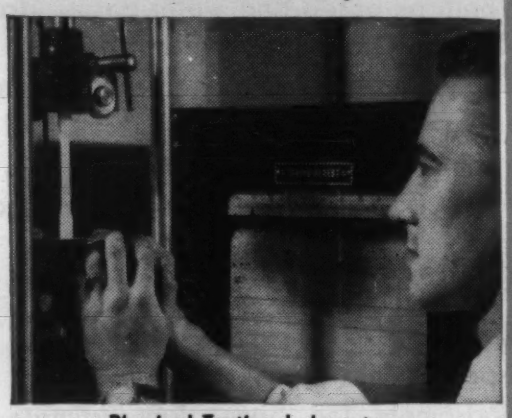
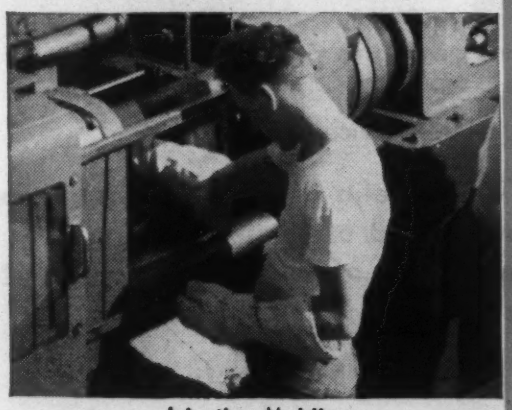


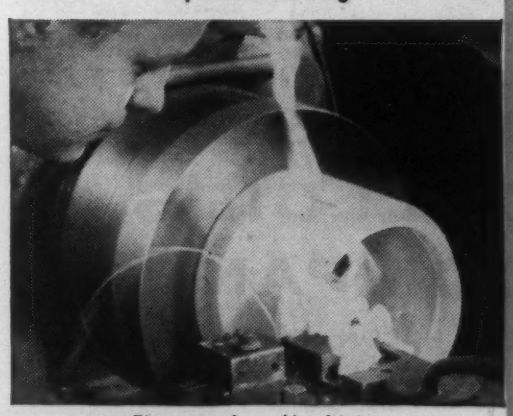
Electronics Test Cage



Physical Testing Laboratory



Injection Molding



Fluorocarbon Machining

The United States Gasket Company is the recognized leader in the fabrication and application of the "Wonder Plastics", duPont TEFLON, Kellogg KEL-F and BAKELITE Fluorothene—leadership earned through many years of pioneering.

Today, this company offers engineering and manufacturing talent and facilities unmatched in the industry to assist its customers in the profitable application of Fluorocarbon Products for almost countless purposes.

To render this service, three highly specialized laboratories are maintained—electronic, chemical and physical—staffed by engineers who continue to produce most of the advanced ideas and practices in the application of these plastics to commercial, A.E.C. and military requirements.

Manufacture is Quality Controlled, utilizing the most modern facilities for rapid, low cost production. Many machines and equipment have been designed or converted by our own engineering department to the peculiar requirements of Fluorocarbon Plastic Fabrication.

• Write for the twenty-page brochure "Inside U. S. G." that suggests how this organization can fit into your development and production program.

U S G BELMONT

UNITED STATES GASKET CO.

CAMDEN 1, NEW JERSEY

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OTHER NEW MATERIALS, PRODUCTS

a dry adhesive that is made pressure-sensitive by applying a solvent. The tape has a total thickness just under 4 mils and is supplied on a polyethylene-coated protective liner.

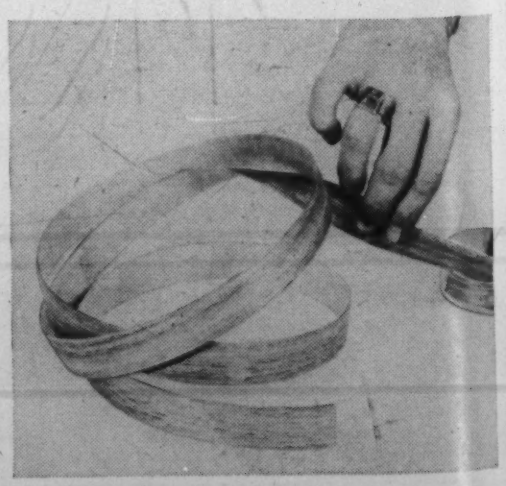
Because of its solvent-activated adhesive, the tape is claimed to have two to three times the normal adhesion of pressure-sensitive tapes. It has 11 lb/in. width tensile strength, 80 oz/in. width adhesion to aluminum and steel, and 44% elongation. Available in six colors, it is readily printed by the silk screen process and with flat bed and rotary aniline presses.

The tape, which is especially suitable for die cuttings, conforms to military specifications for exterior decalcomanias on aircraft. In addition, it is recommended for sealing, holding and labeling where extremely high hold, plus air, solvent and fungus resistance, is required.

3. Wood veneer

An inch-wide tape of wood veneer, packaged in rolls, has been developed by *U. S. Plywood Corp.*, 55 W. 44th St., New York 36. Designated Weldwood Wood-Trim, it is available in mahogany, oak, walnut, birch and Korina to match the most popular plywood faces.

The veneer, 1/85 in. thick, is flexed and mounted on a latex-impregnated backing. It can be cut with scissors, knife or razor blade and can be applied with any high quality wood glue. No heat



***Veneer trim tape** requires no heat or clamping.*

THROUGH 6 STAGE DRAW...

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Hunter Douglas Pre-Painted Aluminum Strip Forms Readily, Eliminates Painting and Finishing Costs!

Now available in a complete color range!

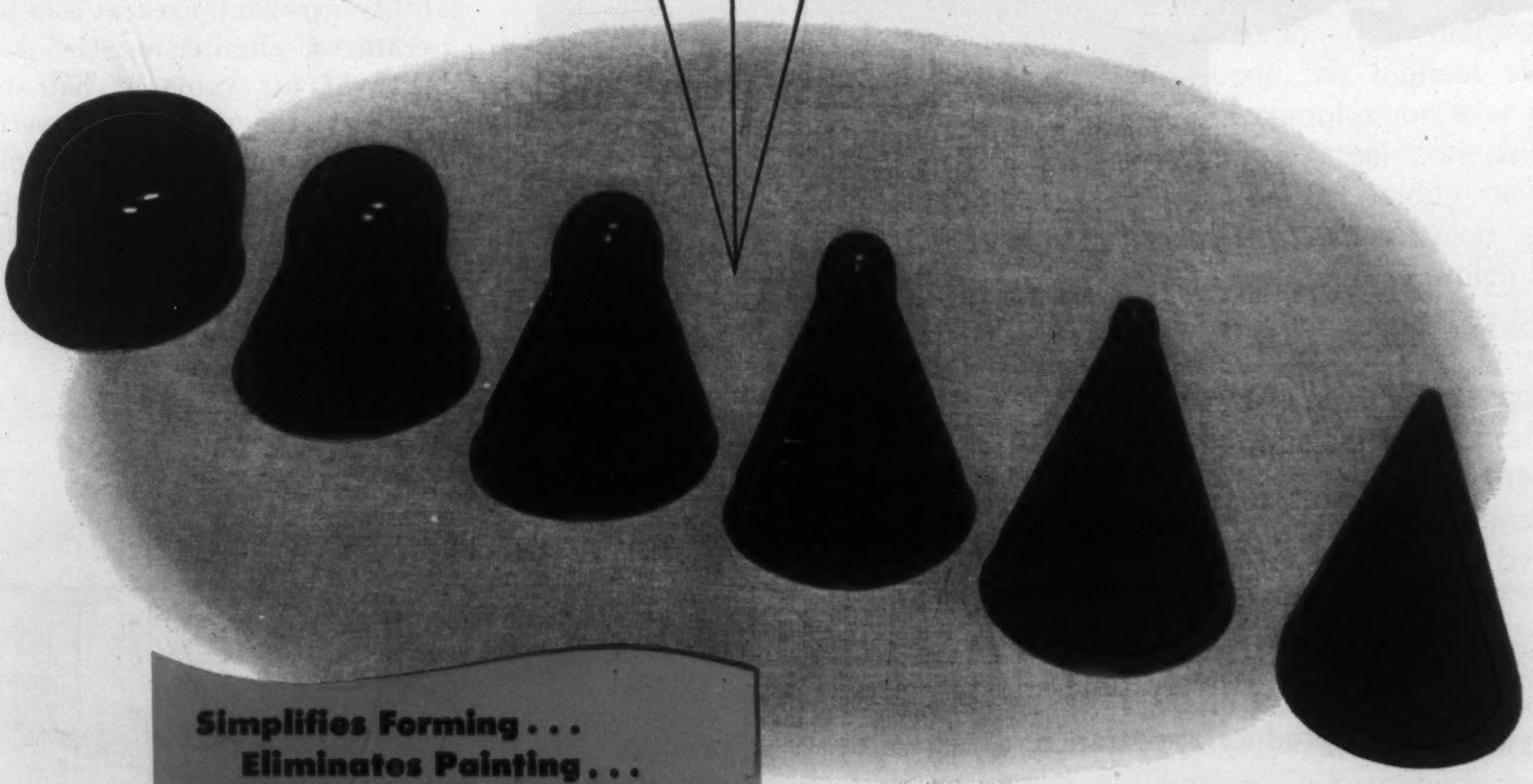
Here's visual testimony to the unusual elasticity of the painted surface on Hunter Douglas Pre-Painted Aluminum Strip! The cone illustrated was deep-drawn through six successive stages on a transfer press. Even though these dies were not specifically made for forming aluminum, and were experimentally applied, the deep draw was highly successful. Not a single blemish occurs on the pre-painted .035" 61S type aluminum stock!

This new Hunter Douglas achievement provides the metal forming industry with a better pre-painted strip which can be readily *roll formed, embossed, stamped* or *deep-drawn* without damage to the surface!

TWO COAT ENAMEL FINISH gives a hard, lustrous surface. Can be secured in a wide range of colors to harmonize or contrast with other decor. The double coating, with each coat individually baked, possesses remarkable adhesion and scratch resistance.

EXTERIOR DURABILITY COMPARABLE TO AUTOMOBILE FINISHES. This strip can be used for exterior purposes as well as for general commodities. Finishes are unusually color fast in sunlight, resistant to heat and cold and successfully pass 500 hour, 90°, 20° salt spray test without lifting or blistering.

STOCK SPECIFICATIONS. Mill quantities available in several aluminum alloys and tempers up to 8" wide, maximum; nominal thicknesses.



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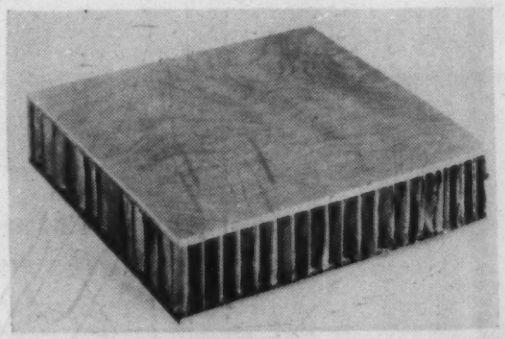
OTHER NEW MATERIALS, PRODUCTS

or clamping is required. Wood-Trim may be applied to curved edges, rolled or bent. The danger of cracking the veneer is said to be almost entirely eliminated.

4. High voltage cable splicing

A "Scotch" brand No. 23 electrical tape has been announced by *Minnesota Mining & Mfg. Co.*, Dept. D6-12, 900 Fauquier St., St. Paul 6, Minn. The self-bonding tape has a butyl rubber base and a dielectric strength of 650 v/mil. It passes the ozone resistance test in MIL-I-3825 and is intended for use as primary insulation on splices made on cables using ozone-resistant insulation.

After application, 3M says, the tape fuses into a homogeneous mass, yielding maximum moisture resistance. A 900% elongation value makes the tape's conformability excellent, even at cold temperatures, eliminating the possibility of air voids or hot spots even at the point of overlap. After the tape has been applied for as little as 5 min, it cannot be removed without rupture of the tape. The tape is said to have no corrosive effect on copper or silver.



***Lightweight panel** is now being made in continuous lengths.*

Continuous Sandwich Structural Panels

A strong, lightweight structural panel, made of paper honeycomb sandwiched between polyester-glass laminates, is available from *Continental Can Co., Honeycomb*

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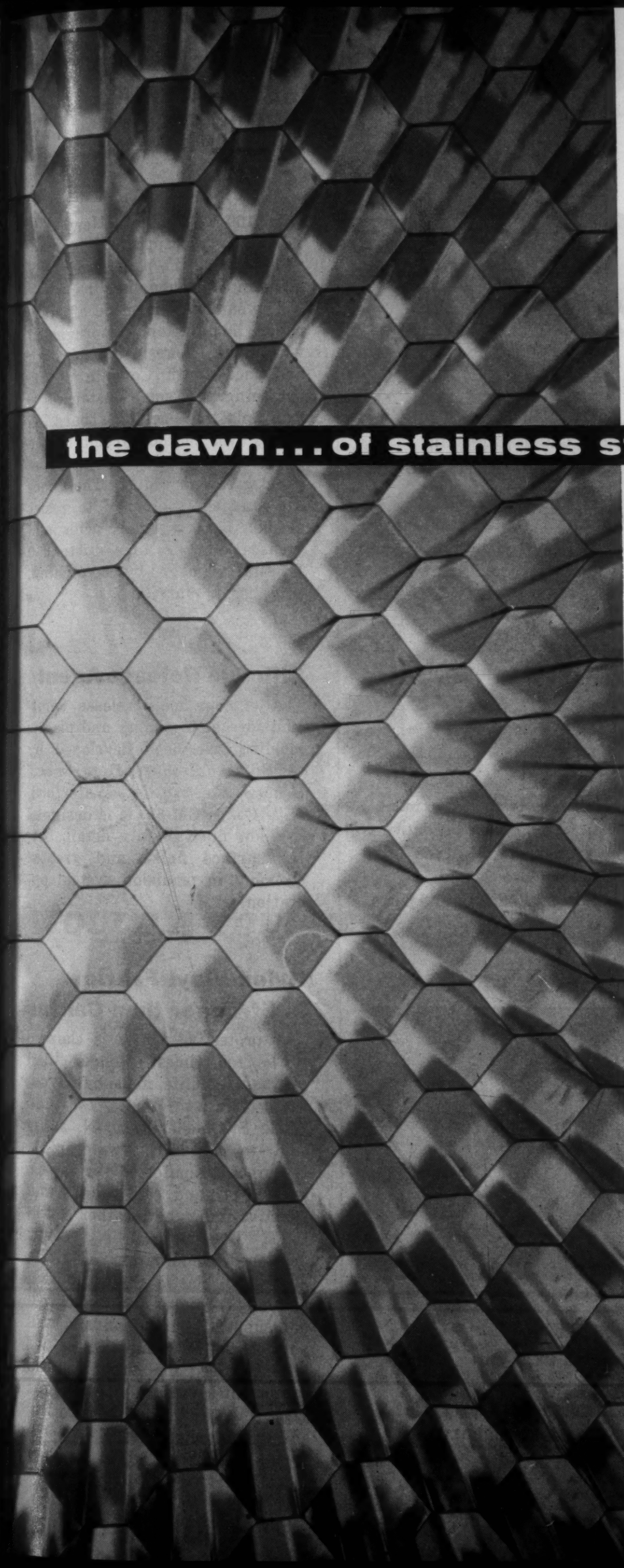

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After five years of pilot production and research, HEXCEL Products Inc. has now perfected a high speed production line for the manufacture of low cost stainless steel honeycomb core material—a development which opens a new horizon for sandwich construction in the aircraft industry. Capable of greater strength than either glass fabric or aluminum honeycomb — two materials which produced the highest strength-to-weight combination ever developed —stainless steel core will provide a degree of rigidity never before achieved in sandwich structures. The new material, which has excellent strength properties at temperatures of up to 1000° F., means low cost and high efficiency construction for many primary aircraft parts. It also makes practical the manufacture of high speed aircraft previously "board-bound" by the thermal barrier.

If you think stainless steel honeycomb could solve an aeronautical design problem of yours, write for further information to HEXCEL Products Inc., 951 61st Street, Oakland 8, California. H 356 A

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America's leading producers
of honeycomb core materials

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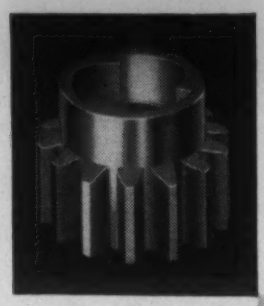

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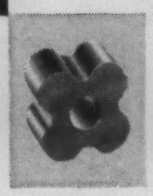
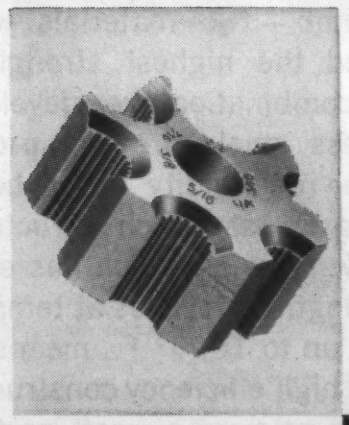
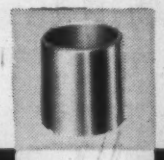


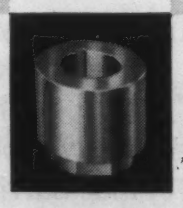
Bunting today covers a new area in the engineering and manufacture of bearings and machine parts. To the traditional line of Bunting Cast Bronze Bearings and parts is added up-to-date, soundly established facilities for engineering and manufacturing bearings and parts made of Sintered Powdered Metals.

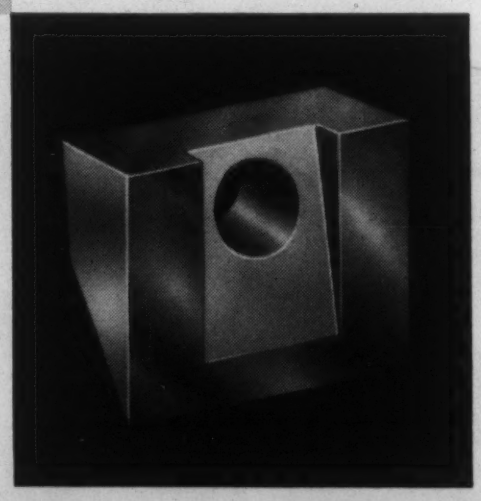
In an entirely new plant with the very latest equipment, Bunting now attains the position in the Sintered Powdered Metals field which it has long held in the field of Cast Bronze Bearings.



A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.







MAY *is* NATIONAL WATER SYSTEMS MONTH

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OTHER NEW MATERIALS, PRODUCTS

Div., 100 E. 42nd St., New York 17. Seam-free application is possible because the panel product is made in continuous lengths.

The sandwich is made of kraft paper honeycomb, impregnated with phenolic resin for rigidity and faced with Conolite plastic surfacing. In some instances, a firm plastic backing board is placed over the honeycomb before Conolite is applied to give the panel greater rigidity. The Conolite surface is claimed to resist alcohol, boiling water, acids and greases; temperatures up to 350 F; and damage by scratching, chipping or marring.

Silicone Release Agent

A silicone mold release emulsion for use in rubber and plastic molding has been developed by the *Silicone Products Department, General Electric Co.*, Waterford, N.Y. Called SM-62, it is designed to allow finer surface detail, better surface finish and greater economy in emulsion system operation.

Nylon-Vinyl Fabric Is Stronger than Canvas

A protective fabric is claimed to be ten times stronger than canvas. Herculite, made by *Herculite Protective Fabrics, Inc.*, 140 Little St., Belleville 9, N. J., is said to be 100% waterproof; tearproof; unaffected by acids, grease, oil and salt water; and effective under all weather conditions. The material is a newly developed combination of nylon and vinyl plastic that has been specially formulated so that it will not support combustion and will not crack at temperatures of −35 F. Used for tarpaulins and equipment covers, its light weight saves time and labor in covering and uncovering.

(More New Materials on p 204)

WOULD A TOUGHER STEEL CHANGE YOUR PLANS?

New Lukens "T-1" steel has three times the yield strength of carbon steel—cuts equipment weight, cuts costs!

■ Here's a new alloy steel with unusual resistance to abrasion, impact and atmospheric corrosion . . . that *stays* tough at temperature extremes. And where extra strength is required from plate steel, Lukens "T-1" steel makes possible substantial overall savings in material.

If you plan or purchase bridge parts, construction machinery or any general industrial equipment, check Lukens "T-1" steel now! Its rugged on-the-job performance can reduce maintenance expense and replacement costs—often provide longer service life!

The latest addition to a complete line of carbon, alloy and clad steels, this all-purpose material is obtainable from Lukens in the widest range of plate sizes available anywhere! Whether you want specific product information or the best ways to make the most of it, write to Manager, Marketing Service, 850 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.

Whatever your plans—now's the time to change to . . .

LUKENS "T-1" STEEL

LUKENS

THE NEWEST IN A COMPLETE LINE OF ALLOY STEELS
LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

For more information, turn to Reader Service Card, Circle No. 364

- ☐ **BRUSHES** for all rotating electrical equipment (Automotive-Aviation-Industrial-Traction, etc.)
- ☐ **GRAPHITE TUBE ANODES**
- ☐ **GROUNDING RODS** for protection against rust (earth and water types)
- ☐ **NON-WELDING ELECTRICAL CONTACTS**
- ☐ **VOLTAGE REGULATOR DISCS** (carbon piles)
- ☐ **WATER HEATER and PASTEURIZATION ELECTRODES**
- ☐ **BEARINGS**
- ☐ **WELDING RODS**
- ☐ **WELDING PLATES and PASTE**
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"EVERYTHING IN CARBON BUT DIAMONDS!"

- ☐ **SPECTROGRAPHITE**
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- ☐ **FRICTION SEGMENTS**
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- ☐ **CHEMICAL CARBON and GRAPHITE ANODES** (Plain or treated)
- ☐ **CARBON RODS FOR SALT BATH RECTIFICATION**
- ☐ **CLUTCH RINGS**
- ☐ **ELECTRIC FURNACE HEATING ELEMENTS**
- ☐ **BRAZING FURNACE BOATS and FIXTURES**
- ☐ **CONTINUOUS CASTING DIES**
- ☐ **PUMP VANES**
- ☐ **PURE CARBON** . . . and many other carbon-graphite-metal powder products

STACKPOLE

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STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

For more information, turn to Reader Service Card, Circle No. 394

OTHER NEW MATERIALS, PRODUCTS

Metal Cleaner

A nonflammable industrial solvent is said to have cleaning properties closely resembling those of carbon tetrachloride, but is claimed to be 20 times less toxic. Vinsol, made by *Speco, Inc.*, 7308 Associate Ave., Cleveland 9, is recommended for removing oil, grease, wax and tars from hand tools, sheet metal, tubing and other metal products. It is adaptable for bucket, dip and cold cleaning.

Two Materials for Barrel Finishing

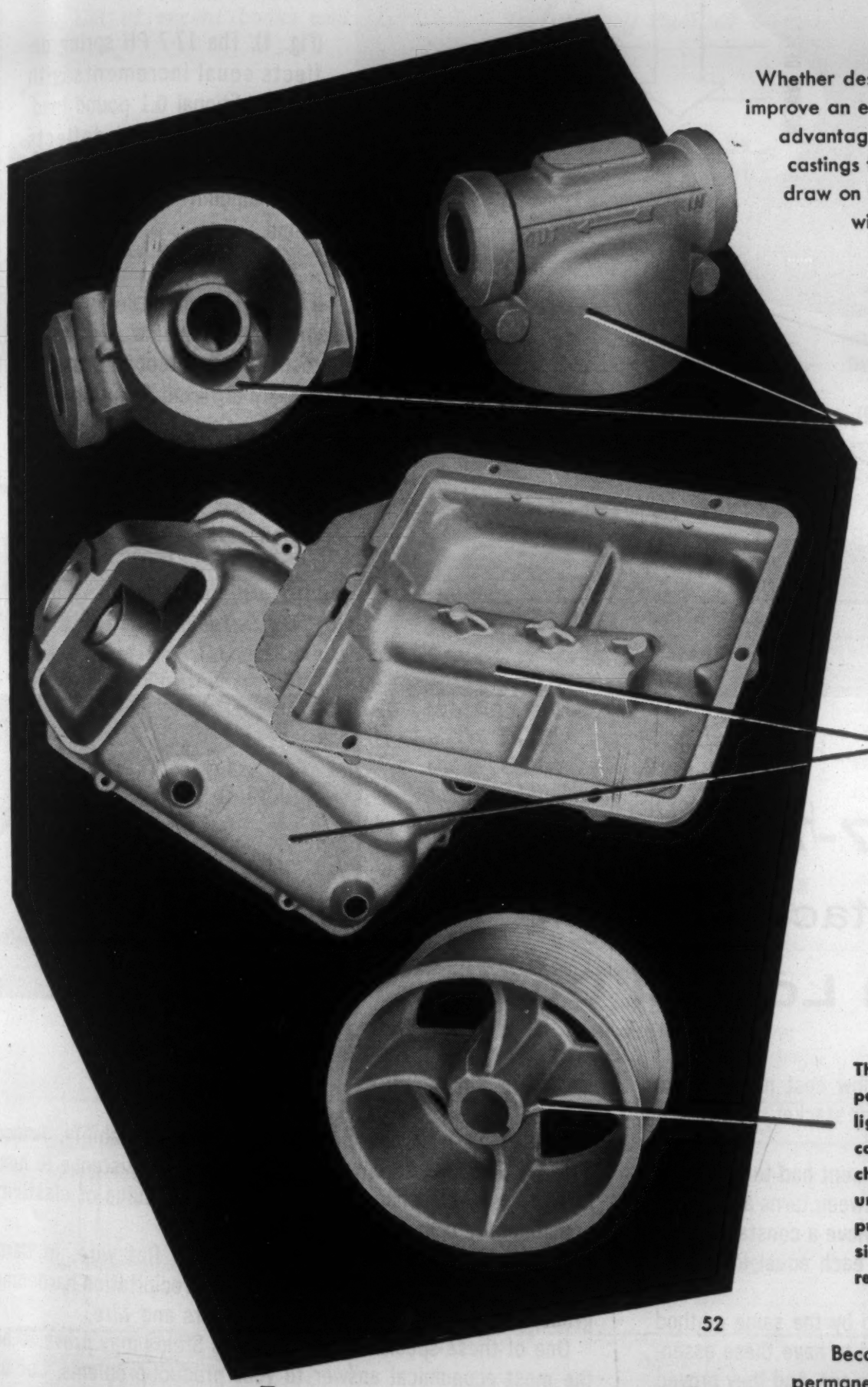
Abrasive media recently developed for barrel finishing include ceramic cones for intricate parts and an unusually durable material composed of rubber and alumina.

The conical ceramic shapes are made by *Minnesota Mining & Mfg. Co.*, Dept. F6-48, 900 Fauquier St., St. Paul 6, Minn. Called Honite brand Ceramicones, the medium makes it possible to barrel finish intricate parts that previously could not be finished in this manner because of lodging problems. The cones are ½ in. high, ⅜ in. across the base and 7/32 in. across the top. According to 3M, the tapered ends permit access to holes for deburring, yet the broad bases prevent lodging, and the cones' resistance to wear enables them to maintain their original dimensions over a long period of use.

The other medium, said to outlast other media by five to ten times, is called Speed-D-Burretts and is made by *Speed-D-Burr Corp.*, 3613 San Fernando Rd., Glendale, Calif. Special compounding of high quality synthetic rubber and pure aluminum oxide results in a medium that allows abrasive action in the most remote corners and recesses of a part without fear of chipping, splintering or cracking.

improving product characteristics by converting to precision

centr-O-cast aluminum castings



Whether designing a new product or looking for ways to improve an established one, you should consider the many advantages to be obtained with high quality aluminum castings from Centr-O-Cast. At Centr-O-Cast, you can draw on the vast knowledge of our engineers for help with your design, and on the experience of our molding section to produce the finest parts from that design.

Part of the high-pressure hydraulic system in an aircraft, this casting must be of minimum weight yet possess the strength to withstand 3750 lbs. bursting pressure. No porosity or inclusions are therefore allowable, and uniform quality is essential. In its heat-treated condition as supplied by Centr-O-Cast, this aluminum alloy casting machines as smoothly and accurately as the finest of free-cutting steels. Thus accurate tolerances in chambers and thread diameters are easily maintained.

Originally produced in cast iron, this burner housing is now cast of aluminum in a cored permanent mold by Centr-O-Cast. The decrease in weight has lessened shipping costs, and made the finished unit easier to suspend in use. The cast-in holes and the accuracy of the permanent mold eliminate the need for machining on the flat surfaces and reduce the amount needed on the cored holes and formed flange. The smoother internal surfaces result in better gas flow and the natural aluminum gives desired reflection.

This overhead door pulley is cast from aluminum in permanent molds. In addition to the high strength and light weight inherent in aluminum, the accuracy of the casting results in a center hole so precise that machining is not needed. And the spiral grooves are so uniform in diameter and correctly spaced that the pulley winds evenly, without danger of raising one side of the door before the other. The aluminum part requires no paint, and resists weathering.

52

centr-O-cast

CENTR-O-CAST AND ENGINEERING COMPANY

45 St. Jean Avenue, Detroit, Michigan

Because we work with many molding techniques—permanent mold, semi-permanent, centrifugal or centrifuge—our engineers are not limited in their recommendations and can better assist you in choosing the right casting method for your product. We work in all the aluminum alloys, have heat-treating facilities, and are equipped to produce castings ranging from 2 ounces to 65 pounds.

Write for our illustrated brochure or a personal call by our casting consultant.

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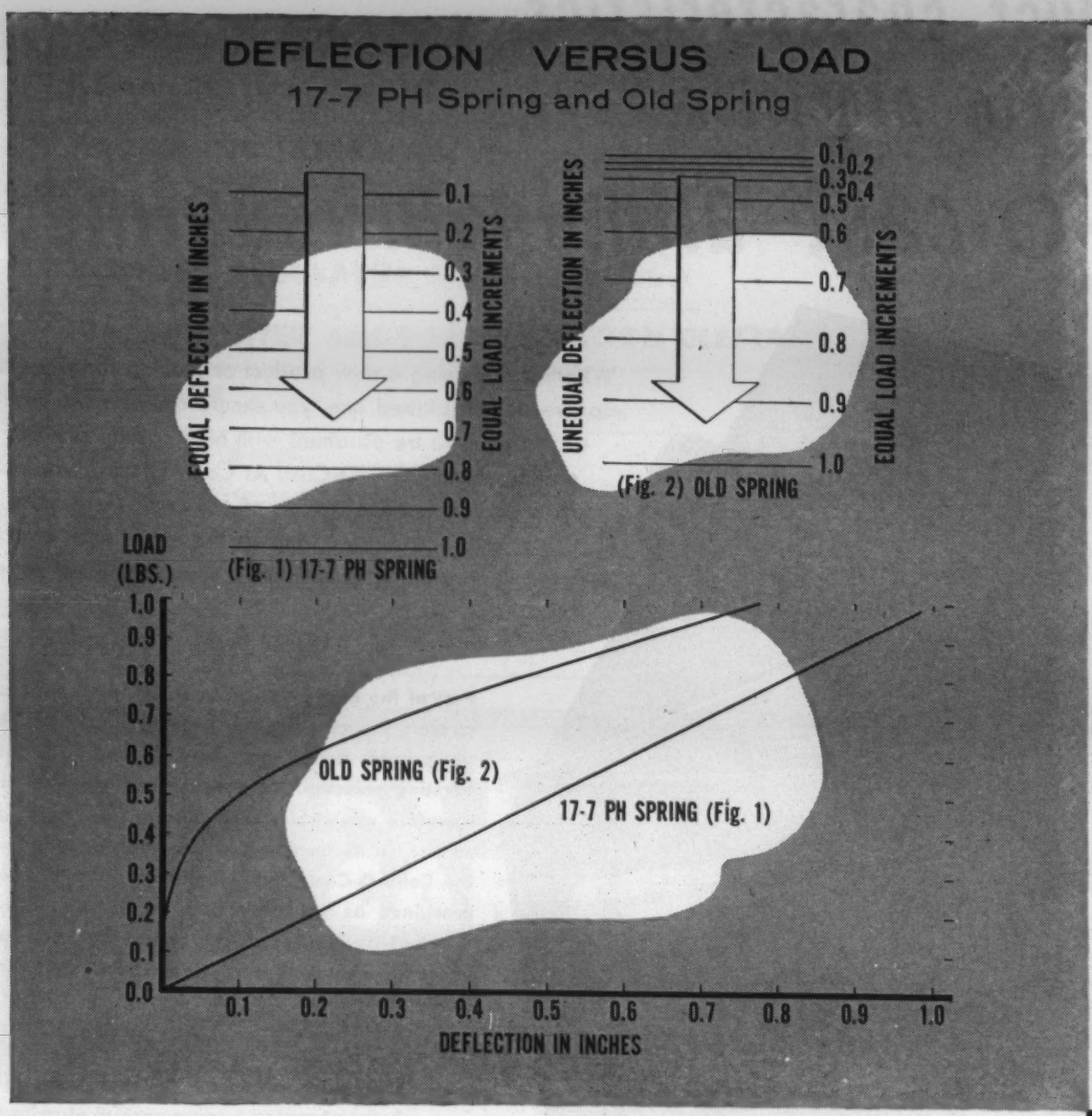
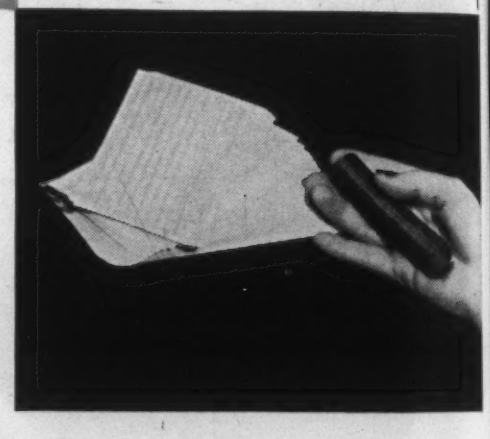


(Fig. 1). The 17-7 PH spring deflects equal increments with each additional 0.1 pound load. The first 0.1 pound deflects the spring almost exactly the same amount as the last 0.1 pound.

(Fig. 2). The old spring deflects unequal increments. Deflection at the first 0.1 pound load is entirely different from the last.



Armco 17-7 PH Wire Solves Stacker-Spring Problem at Lowest Cost

Ideal physical properties and relatively low cost made Armco 17-7 PH Stainless Steel wire top choice for stacker-springs in a new 1000-card-a-minute sorter.

Stacker-springs on this rapid-fire equipment had to have zero initial tension. This meant no pressure between turns at no load. In addition, the springs were required to have a constant stacking rate . . . deflect proportionately for each equal load addition and have close tolerances.

Springs of Armco 17-7 PH wire, formed by the same method as standard extension springs, were found to have these essential properties after one simple heat treatment. And they proved lowest in cost. The only other spring that did the job cost 5 times as much as the 17-7 PH springs.

Versatile Spring Wire

Besides high load capacity and dimensional stability, Armco 17-7 PH Stainless Steel wire offers excellent resistance to heat and corrosion. Mechanical properties and modulus of elasticity are generally comparable to music wire.

Armco 17-7 PH is supplied in round or flat wire, in bars, sheets, strip and plates. A companion precipitation-hardening grade, Armco 17-4 PH, is produced in bars and wire.

One of these special Armco Stainless Steels may prove to be the most economical answer to your product-problems. Let us send you complete information. Just write us at the address below.

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CONTENTS NOTED

Highlights of current papers.
A list of recent books and reports.

This month

- *Alloys for automobile gas turbines*
- *Symposium on electroplates*
- *Filiform corrosion*
- *Joining rubber to metal*

Economical Alloys for Automobile Turbines

Before the gas turbine can be established as an economical power-plant for automobiles, many new classes of high temperature alloys will have to be developed. The need for these alloys stems almost entirely from cost considerations. Were it not for their high price, the high temperature alloys used in aircraft gas turbines would be satisfactory for the stresses and temperatures contemplated in automobile turbines.

In a paper presented before the annual meeting of the Society of Automotive Engineers last January, D. N. Frey summarized the results of work done by Ford Motor Co. to develop new, low cost alloys for automobile turbines. Total turbine costs should come close to, but not exceed, those of present piston engines. The accompanying table gives a breakdown of the weights and approximate alloy costs for a hypothetical 300-hp regenerative gas turbine.

Prior to development of these high temperature alloys, the following limits on the more costly and strategic alloying materials were established:

1. Cobalt—5% max for compressor turbine blade alloys.
2. Nickel—50% max for compressor blades; 5% max for other hot rotating parts.
3. Tungsten, vanadium and molybdenum—2% max in hot rotating parts.

To fulfill these requirements, three classes of alloys are now being developed: 1) iron-base chromium - manganese - nitrogen austenitic alloys, 2) iron-aluminum ferritic alloys containing up to 16% aluminum, and 3) cast ferritic alloys with up to 12% chromium and minor amounts of titanium, vanadium, molybdenum and tungsten.

ESTIMATED COST OF AUTOMOBILE TURBINE ALLOYS

Material	End Use	Finished Weight, Lb	Estimated Max Materials Cost, $/Lb	Max Cost Per Engine, $
A. Very thin ferritic stainless sheet	Heat exchanger	55	0.65 (0.002-in. sheet)	35.75
B. Ferritic stainless sheet	Moderate temperature, high stress ducts; high temperature, low stress parts	48	0.30 (sheet)	14.40
C. Austenitic stainless sheet	High temperature, high stress ducts	45	0.45 (sheet)	20.25
D. Austenitic high temperature alloy forgings	Compressor turbine rotor, et al	14	0.85 (forging billet)	11.90
E. High temperature alloy castings	Compressor turbine blades, et al	10	0.90 (into the mold)	9.00
F. Stainless alloy castings	Power turbine, et al	30	0.20 (into the mold)	6.00
	Total	202		97.30

Manganese austenitic alloys

Present turbine requirements call for high stress alloys operating from 1150 to 1400 F (categories C, D and E in table). Ferritic steels are generally inadequate above 1150 F, and alloys currently used in this temperature range usually contain from 8 to 75% nickel. Nitrogen, more soluble in manganese-bearing austenites than in nickel-bearing austenites, is a powerful austenite former, and the combination of manganese and nitrogen is an attractive substitute for nickel. Indications are that nitrogen contents of 0.5% or more allow the addition of several percent of ferrite-forming hot strengtheners, such as molybdenum, without subsequent austenite decomposition at elevated temperatures.

Properties of these alloys are characterized by high yield and tensile strengths with excellent ductility, even after cold working. The 1350 F creep-rupture properties of chromium-manganese-molybdenum-nickel steels are comparable to those of such popular commercial alloys as 16 chromium-25 nickel-6% molybdenum. Some gas porosity, probably due to nitrogen evolution, has been found in helium- or argon-arc welding tests; however, sound and ductile welds have been obtained in a partial or complete nitrogen atmosphere.

Summarizing the findings for high-nitrogen manganese austenitic steels, it appears that prop-

erties of the simple alloys are adequate for high temperature ducting (category C) and for turbine rotors (category D). Properties are inadequate for compressor turbine blades, however, and development of stronger, more complex alloys is needed.

A definite need exists for an alloy possessing very high oxidation and corrosion resistance and low-to-moderate high temperature strength (category B) for burner can assemblies and nozzle guide vanes. The alloy must be amenable to conventional fabricating techniques such as cold forming and welding. Economic and strategic considerations rule out the nickel- and cobalt-base materials presently used in aircraft turbines.

Iron-aluminum alloys

Iron-base alloys of relatively high aluminum content are known to have excellent oxidation resistance. At least 8% aluminum is required for appreciable oxidation resistance at 1800 F and higher. Careful control of alloy composition, melting procedures and fabrication techniques has done much to improve the ductility and minimize the brittleness associated with earlier iron-aluminum alloys. Earlier investigations showed a sharp drop in ductility at about 5% aluminum; an analagous decrease with present alloys occurs at about 10% aluminum. At this level, oxidation resistance up to 2150 F is obtained—sufficient for the applications cited.

Many elements have been evaluated for improving the strength of iron-aluminum forgings and sheet at operating temperatures up to 1100 F. Results show that titanium and silicon produce the best increase in creep-rupture life.

It appears probable, therefore, that ductile and workable simple alloys containing about 10% aluminum can be economically produced in sheet form for very high temperature, low stress parts such as combustion can liners. The use of aluminum-coated plain carbon steel is another possibility. Cost will probably determine the choice.

It is probable that high stress parts operating at temperatures up to 1100-1150 F can also be made of iron-aluminum alloys. Paradoxically, the aluminum content must be at least 10% to achieve adequate hot strength.

Cast ferritic alloys

In addition to the development of high temperature wrought materials, further development of moderate temperature (up to 1150 F) cast alloys is also required for certain turbine components (category F). In the last decade a number of high creep strength, low alloy ferritic wrought steels have been developed for service in the 900-1150 F range. Many of these alloys (heat treated before machining) were tested by Ford in cast form at temperatures of 1100 and 1200 F.

In this temperature range stress-rupture properties of cast alloys are largely similar to those of wrought alloys. Of those alloys containing less than 4 to 5% alloy content, molybdenum-vanadium - titanium compositions possessed the greatest strength. To improve oxidation resistance some alloy additions were made. A slight decrease in strength was noted with 1.25% chromium, and larger additions up to 3% decreased strength even further. Small aluminum additions had little effect on strength, but larger additions decreased strength markedly.

Of the 12% chromium alloys, the most promising was Type 422 modified. Additions of 0.01 to 0.04% boron lowered stress-rupture properties as the amount of boron increased. Titanium additions had little effect.

Both cast and heat treated molybdenum - vanadium - titanium alloys seem to have excellent strength properties up to 1100 F, but would have marginal oxidation resistance in many turbine applications. The less economical

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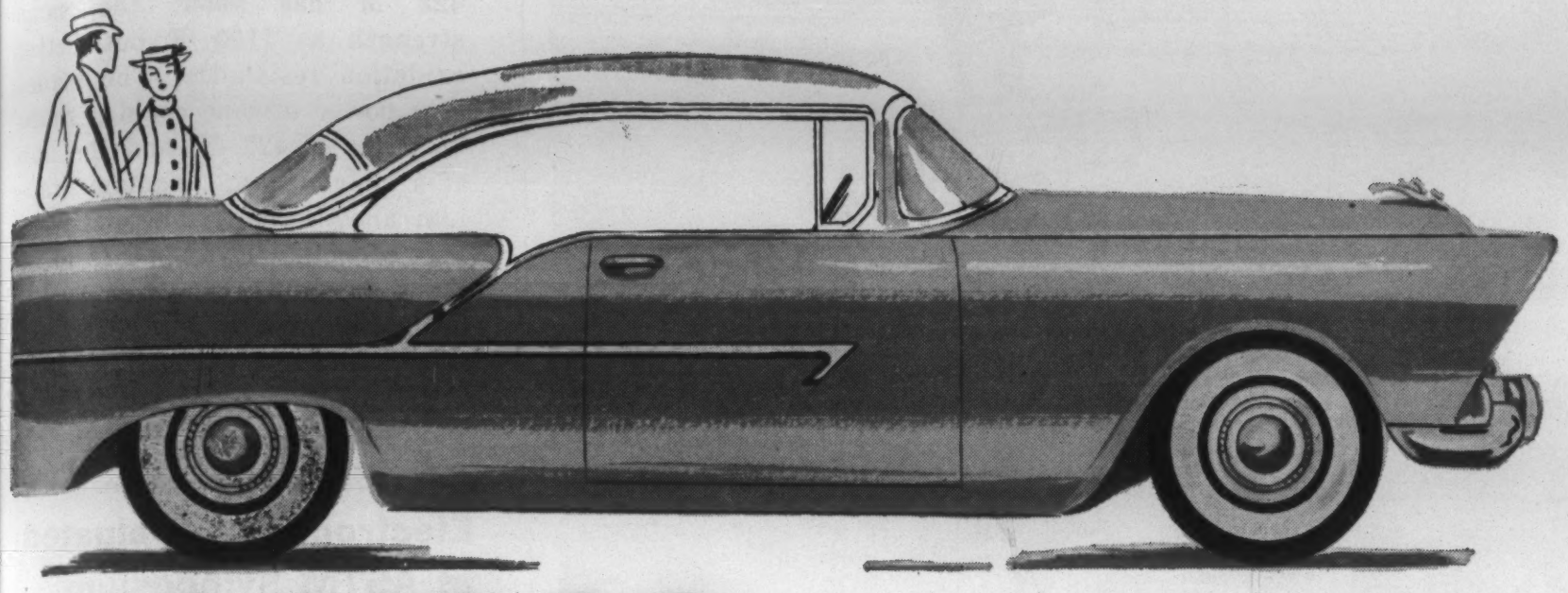

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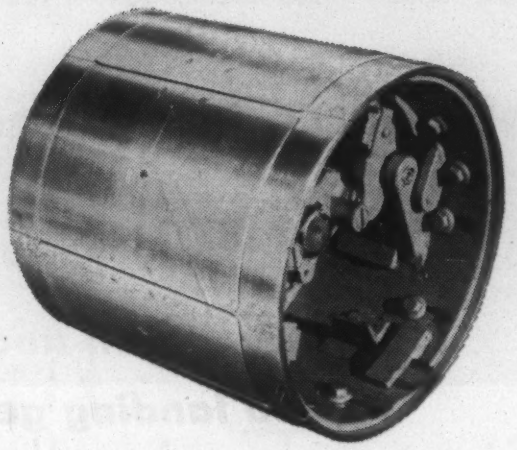
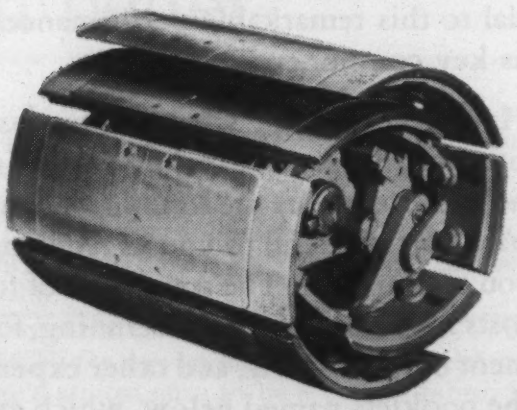


6-SECTION PASSENGER TIRE BUILDING DRUM EXPANDED



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CONTENTS NOTED

422 M has about the same strength at 1100 F but better oxidation resistance. The blades of a power turbine could perhaps be made of 422 M, and the hub of a molybdenum-vanadium-titanium alloy. The prime disadvantage of both alloys appears to be the rather difficult and expensive heat treatments required to develop good high temperature properties.

Electroplates Evaluated at ASTM Symposium

Three interesting reports highlighted a recent symposium on Electrodeposited Metallic Coatings held in Buffalo by the American Society for Testing Materials. They were 1) a report from Committee B-8 which again challenged the validity of the salt spray test, 2) a report on the relative corrosion behavior of zinc and cadmium deposits on steel, and 3) an evaluation of electrodeposited lead as a protective coating for steel.

Salt test again challenged

Used for years to evaluate the quality of metallic coatings, the standard salt spray test came in for some sharp criticism in a report by A. Mendizza of the Bell Telephone Laboratories. He said recent investigations have shown that the salt spray test is neither reliable nor reproducible, and that its use as a standard acceptance test for plated coatings is of doubtful value.

Many users of electroplated coatings have been somewhat reluctant to include the salt spray test in acceptance requirements, since reports from time to time have indicated that the test is not always reliable. In recent years, especially, serious doubt as to the validity of the test, i.e., its ability to measure the quality and predict the expected performance of metallic coatings, has been expressed.

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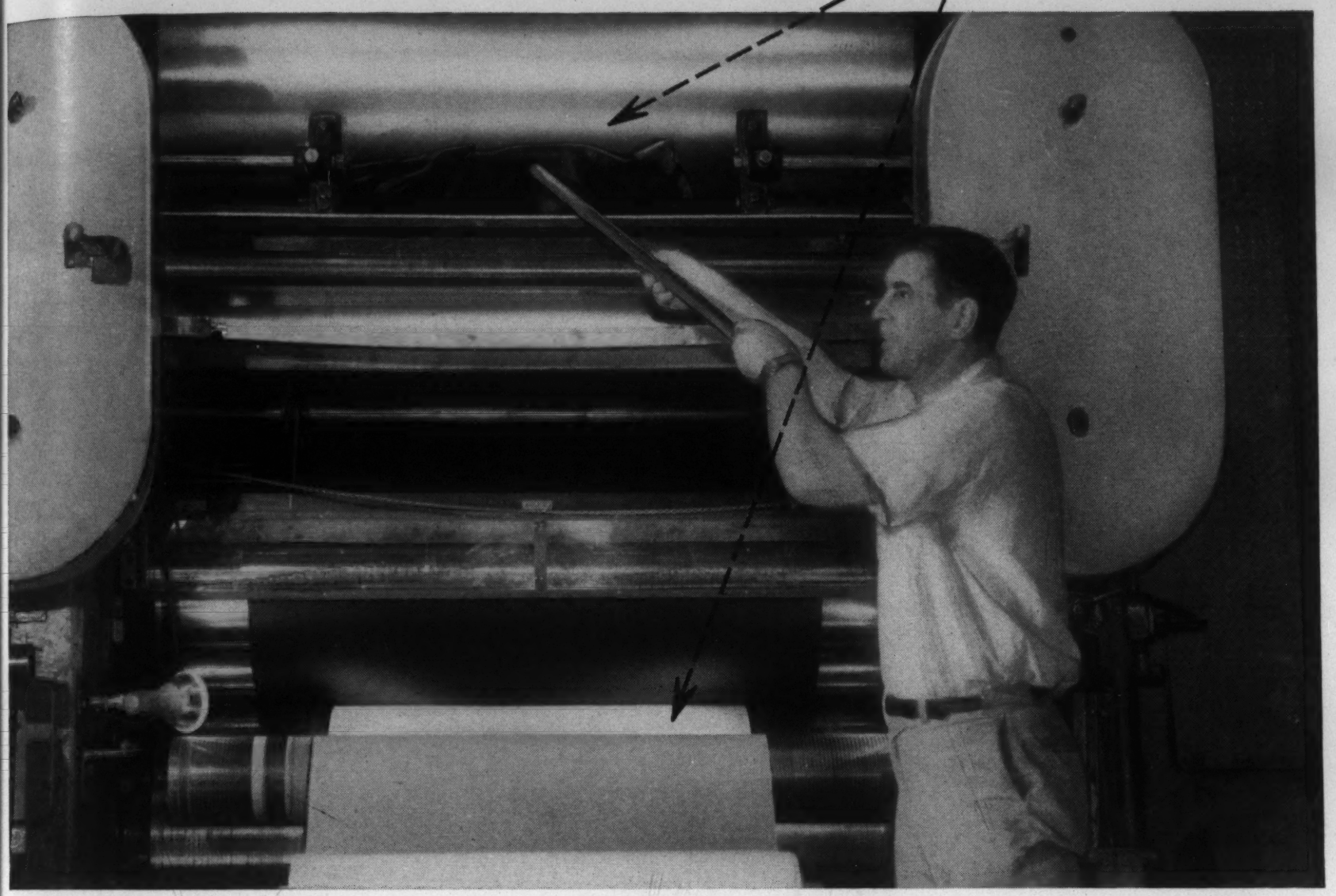

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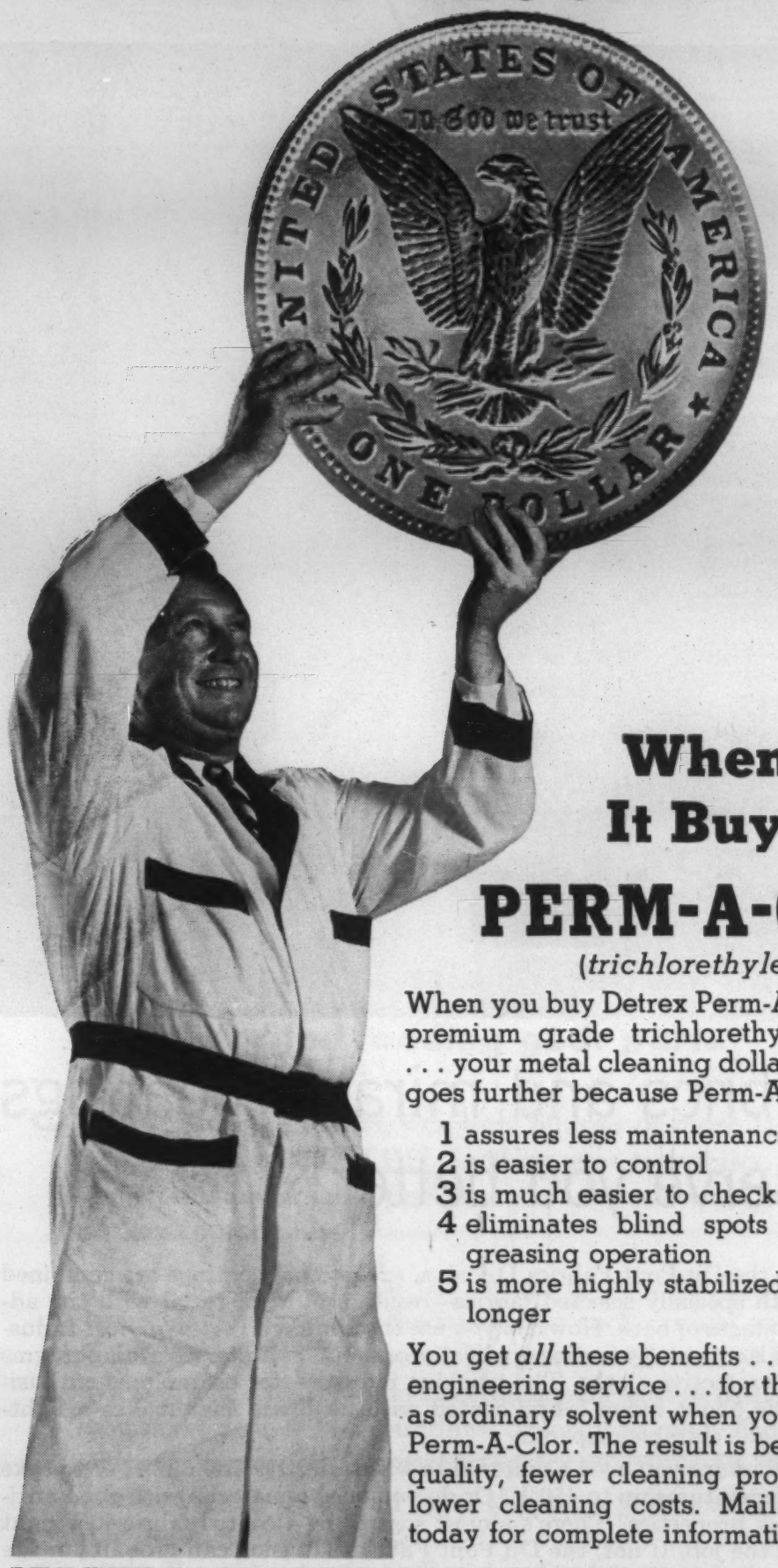

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CONTENTS NOTED

the test can be relied upon, Committee B-8 of the ASTM had set up an investigation to determine the relationship between salt spray resistance and coating thickness, and to determine the reproducibility of results obtained in several testing boxes. Samples of nickel plate on steel from five typical suppliers were evaluated in four different boxes.

Results indicated that: 1) little or no agreement existed in results obtained from the several boxes, and 2) the relative ratings of the coatings depended not only on the coating itself but also on the test box used. Furthermore, the reproducibility of test results was found to be relatively poor even in the same test box. Statisticians estimate that panels would have to be a minimum of 10 sq ft in area in order to obtain the desired level of consistency and reproducibility.

Zinc and cadmium coatings

Also presented by Mr. Mendizza of Bell, along with C. H. Sample and R. B. Tell, of International Nickel Co., were results of an extensive investigation into the relative corrosion behavior and protective value of electrodeposited zinc and cadmium deposits on steel.

Steel panels with coatings from 0.05 to 2 mils in thickness were exposed to industrial, rural and coastal atmospheres at New York City, Kure Beach, N. C., Perrine, Fla., and Steubenville, Ohio. Also, accelerated corrosion tests on replicate panels were conducted in a humidity cabinet in which moisture condensation was induced twice daily, and in standard salt spray cabinets employing 20% sodium chloride, 3% sodium chloride and fresh sea water.

As expected, both coatings fail more rapidly in industrial atmospheres than in marine or rural locations. In some industrial locations a zinc coating lasted significantly longer than a cadmium coating of the same thickness, however, in industrial environ-

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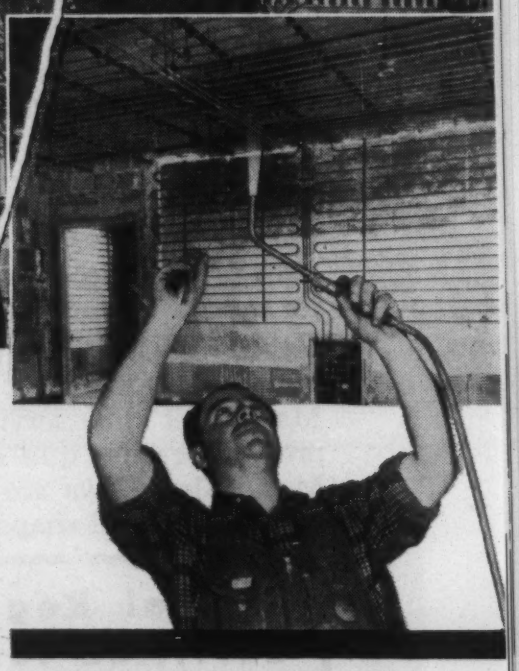

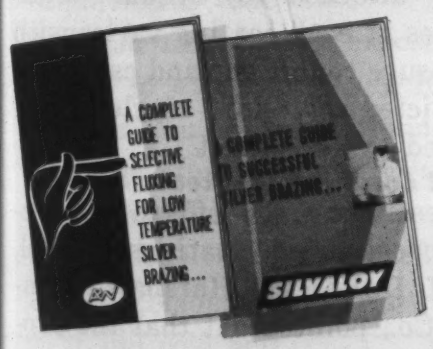

These two complete reference manuals for low temperature silver brazing and fluxing are available upon request. Send for either one or both.

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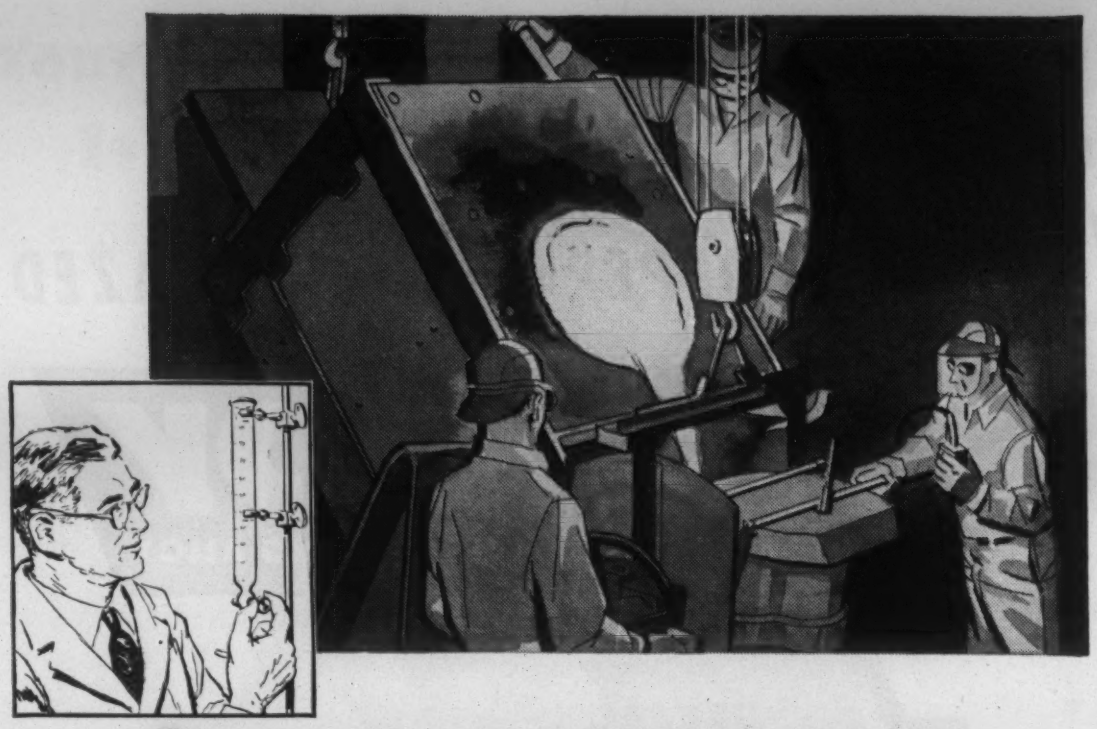

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ments particularly corrosive to zinc there does not appear to be any significant difference between the two coatings.

In marine and rural locations, the longer life of cadmium coatings was demonstrated. These coatings also showed considerably longer life in a salt spray (fog) test. Conversely, zinc coatings proved better in fresh sea water tests. It should be noted, however, that for exposure periods exceeding 15 hr the corroded areas of cadmium coatings are masked by calcareous deposits. Consequently, there is little correlation between data obtained in salt or sea water exposure tests and that obtained from exposure to actual atmospheres.

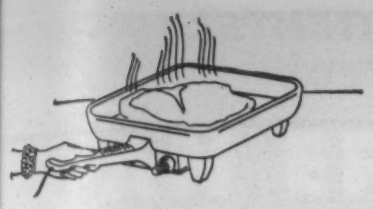
In warm humid atmospheres conducive to condensation, zinc coatings fail sooner than cadmium coatings of the same thickness. In environments where electrolyte conductivity is low, both coatings may exhibit pinhole rusting.

From these tests the authors conclude that the relative protection afforded by equal thicknesses of each coating varies with exposure conditions and cannot be predicted by any single accelerated exposure test.

Lead coatings on steel

Describing the effects of electrodeposited lead coatings on steel, A. H. DuRose, of Harshaw Chemical Co., pointed out that the protective value of a lead coating in various atmospheres is related directly to the corrosion rate of lead alone. The corrosivity of bare steel has no direct relationship to the degree of protection afforded steel by the lead. Damage to the steel base is an inverse function of coating thickness at all locations.

Lead coatings have been found to perform better in industrial than in marine atmospheres. For all coatings except very thin ones, a copper undercoat helps to retard the rate of steel corrosion. Under continued weathering, how-



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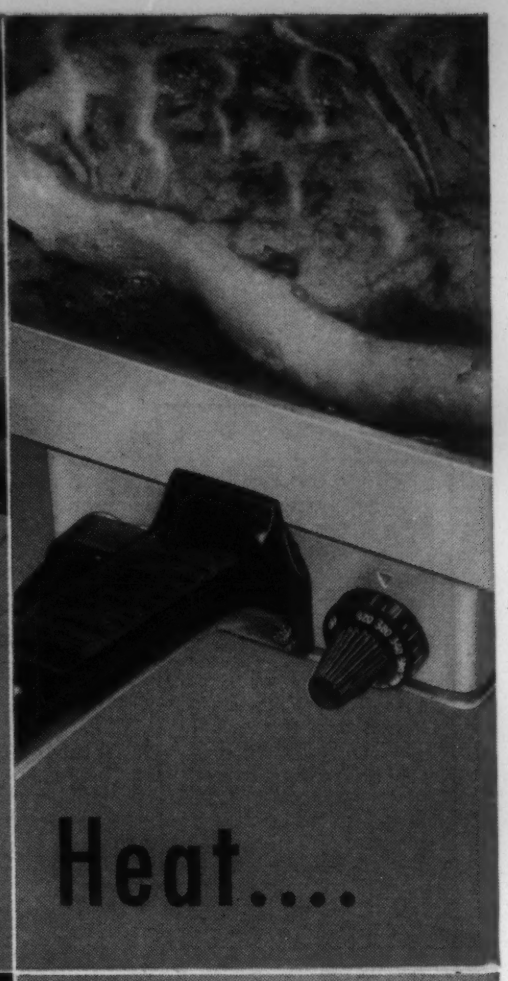

Heat....

Dishwater....

Designers of a new electric frying pan located the control box underneath the handle. This position was ideal for servicing, but it meant that the control box would be completely immersed in dishwater when the pan was cleaned. One of the primary problems was to find a material that would effect a watertight seal under the three screws fastening down the control box cover. Requirements were stiff.

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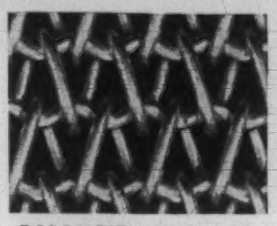

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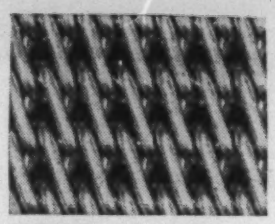
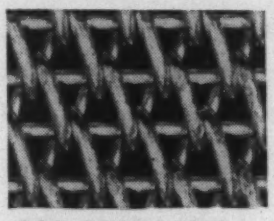
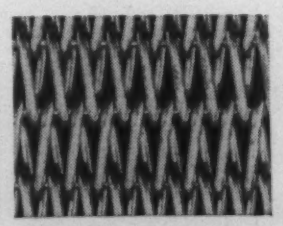


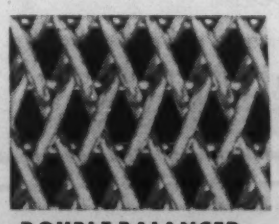
DUPLEX—Compact structure of great density provides high tensile strength, while close mesh provides smooth surface for carrying small parts.



ROD-REINFORCED—Highest tensile strength and low thermal capacity. Recommended for high temperature work, up to 2100°F. Undergoes minimum elongation and width contraction.



GRATEX—Close spirals retain the advantages of Balanced weave, while adding strength. For cold, medium and some high temperature applications.



DOUBLE BALANCED—A widely used weave combining open mesh of Balanced Weave with the strength of Gratex. For cold, medium and some high temperature applications.

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However, there is no single type of belt construction suitable for all operations. Some must withstand the rigors of higher temperature service—up to 2100°F.; some require fine mesh for handling small parts; others must resist the corrosive attack of pickling processes and cooling operations. That's why Cambridge has nine basic weaves available in any metal or alloy. The five shown here are the most widely used in the metalworking industry.

There are several factors that generally influence selection of weave, mesh size and metal or alloy from which the belt will be woven. Among them are: size and shape of the parts to be handled, temperatures to which belt will be subjected, presence of wet or corrosive conditions. Even after these have been decided, overall belt construction must be designed to meet individual requirements—type of drive, selvage, support and special surface attachments must be selected.

You can see, then, that designing for continuous processing with woven wire conveyor belts is not a simple "nuts and bolts" job. Ramifications build up rapidly to demand the service of a specialist. That's why Cambridge maintains a staff of competent Field Engineers to help you select the Woven Wire Conveyor Belt to make your installation most efficient. You can rely on the experience of these engineers to specify just the right belt for you. In addition, they are thoroughly familiar with basic conveyor design. For the name of your nearest Cambridge Field Engineer, look under "Belting, Mechanical" in your classified telephone book. Or, write direct. Also ask for Special Report, "6 WAYS to Increase HEAT TREATING PRODUCTION", and 130-page Reference Manual of specifications and design information. THE CAMBRIDGE WIRE CLOTH CO., DEPARTMENT A, CAMBRIDGE 5, MD.

For more information, turn to Reader Service Card, Circle No. 388

ever, the thickness of the le may be reduced to such a poi (about 0.08 mil) that the proce reverses itself and the copp undercoat actually accelerates co rosion.

Filiform Corrosion: What and Where

In addition to the general known forms of corrosion, a ne form known as "filiform corro sion" is currently attracting wid interest. As explained by A Buckowiecki in the May '55 issu of *Schweizer Archiv* (Swiss), fil form corrosion does not eat in way into the depths of the meta but remains on the surface an appears in the form of thread Impairment of the mechanica properties of the corroded mate rial is rarely noticeable, but trace of corrosion of this type are s unsightly that preventive step are usually required.

Some of the observed characte istics of this form of corrosio are:

1. It occurs under paint film on iron, aluminum and magne sium surfaces.

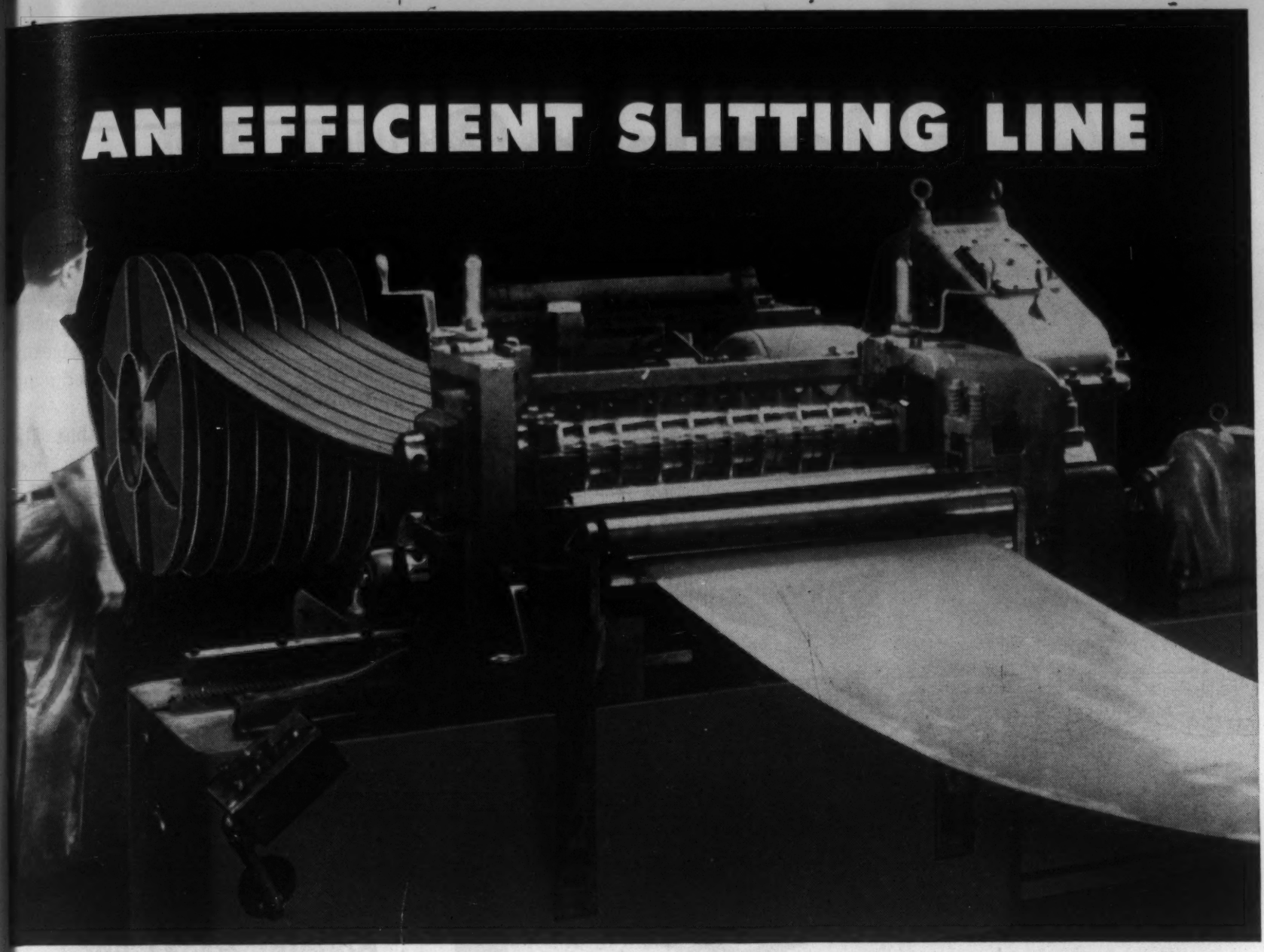
2. Absence of threads along grain boundaries. However threads sometimes follow scratche in the metal surface.

3. It occurs beneath several types of clear and pigmented paint. With pigmented films, cor rosion takes place only if a criti cal pigment concentration has been exceeded or if there is insuf ficient bonding agent to enclose all pigment particles.

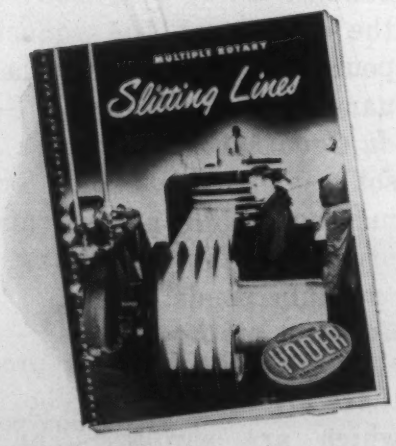
4. The usual rust-preventing pigments and added inhibitors cannot prevent the formation of corrosion threads.

5. No filiform corrosion takes place under a coat of paint if the metal has a perfect phosphate sur face layer.

6. Filiform corrosion of steel depends on humidity. At relative humidities under 65% there is no evidence of corrosion; between 65



...with big savings possibilities



The Yoder Slitter Book contains time studies, production records, and other valuable data on the economics as well as mechanics of slitter operation. A copy is yours for the asking; also estimates and recommendations.

The standardized series of Yoder Uncoilers, Slitters and Recoilers make possible an infinite number of combinations for highly efficient coil and sheet slitting.

At a substantial saving in first cost, one of these combinations will meet widely varying production needs of fabricating shops as efficiently as higher priced, built-to-order equipment (also designed and built by Yoder) for very big tonnage requirements.

A Yoder standardized slitting line is a most profitable production tool which will pay for itself in short order on strip requirements as low as 100 tons per month, even less. Equally important is the ability in a few hours to meet expected and unexpected needs for slit strands, from a relatively small stock of standard width coils. This greatly reduces strip inventories and simplifies production planning.

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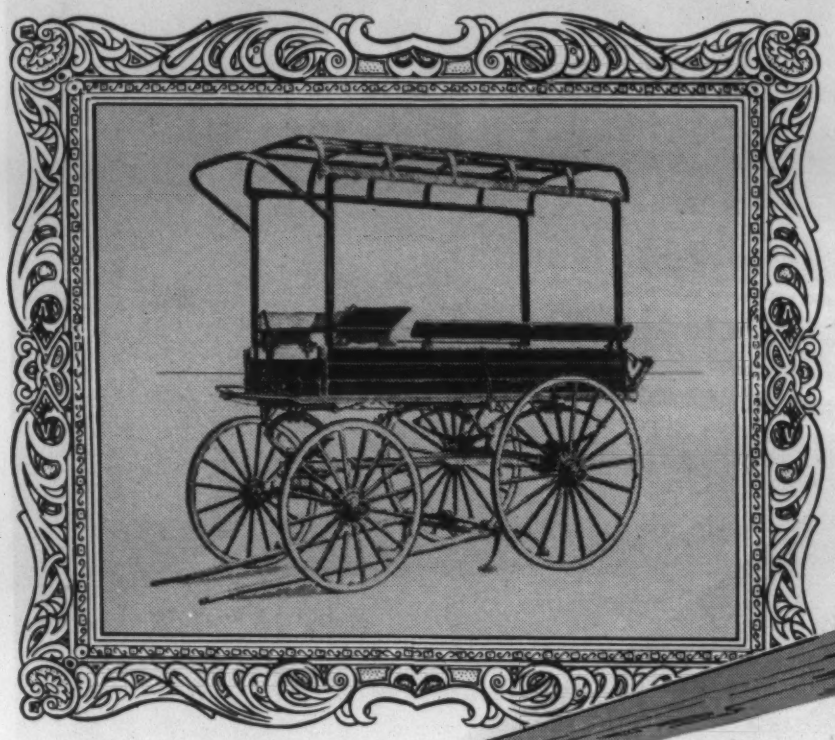
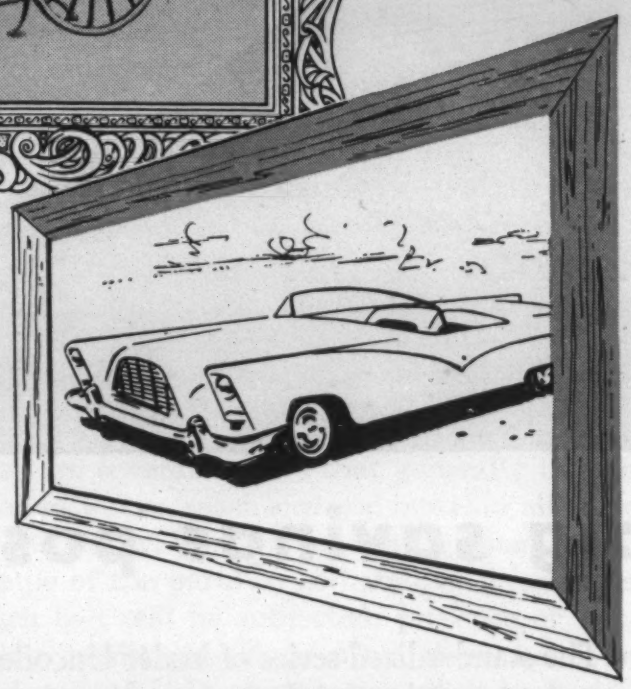
How about Malleable?



Wagon of about the year 1885, completely "ironed" with standard malleable iron castings.



New metals aren't the only answer! For 130 years malleable iron has kept pace with modern design requirements

Malleable proved its worth long ago in parts requiring toughness, ductility and resistance to shock. Through years of processing refinements, today's malleable iron is a superior metal, adaptable to meet job demands—ties in with modern-age requirements.

Versatile castability, high ratio of yield point to ultimate strength, and remarkable ease of machining mark malleable for new uses every day. And still further advancements in malleable and pearlitic malleable production assure higher capacity to serve new users whose forward planning and design awareness recognize the many advantages of this "old-new" material.

It's worth your while to take malleable iron castings into consideration when designing new products or when seeking new cost and assembly savings. Consult your nearest malleable foundry, or write to this Society for information.

Malleable FOUNDERS' SOCIETY

1800 Union Commerce Building Cleveland 14, Ohio

For more information, turn to Reader Service Card, Circle No. 407

CONTENTS NOTED

and 93%, only small amounts of filiform corrosion are evident. From 93% upwards, broad, thread-like rusty swellings appear.

7. Growth of threads already formed can be stopped by reducing humidity to 65%.

The authors suggest that filiform corrosion threads can best be prevented by keeping metal surfaces clean and free from hygroscopic deposits, and by carefully coating metals immediately after surface preparation. Strong oxidizing additives are recommended if special inhibitors are used.

(Adapted from a digest appearing in the Feb '56, issue of *EPA Technical Digests*, distributed by the Organization for European Economic Co-Operation.)

Rubber-to-Metal Bonding Processes

In order to obtain the strongest bonds between rubbers and metals bonding must take place during the curing of the rubber compound. In an article in last January's issue of *Revue Générale du Caouthchouc* (French), J. Gossot summarizes the available methods, both general and proprietary, for obtaining these optimum bonds.

Bonding methods

For all the bonding processes, there are certain basic operations which are similar. The metal surface should always be perfectly clean. Surfaces should be degreased, then rid of surface dirt and scale by an appropriate cleaning method. Initial coats of priming material should be applied as thinly as possible consistent with complete coverage. The bonding operation should be carried out in a dry atmosphere.

Primer coats should be covered with a coat of the rubber to be bonded, observing the same precautions against high humidity as are necessary during the application and drying of the primer. Though this second coat is not

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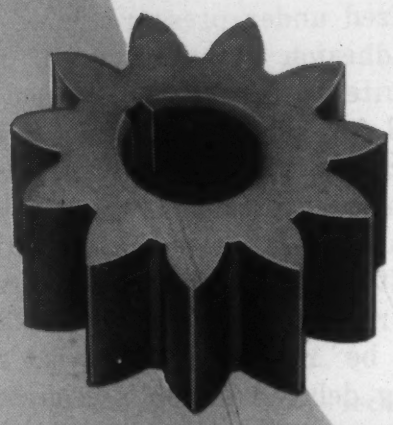

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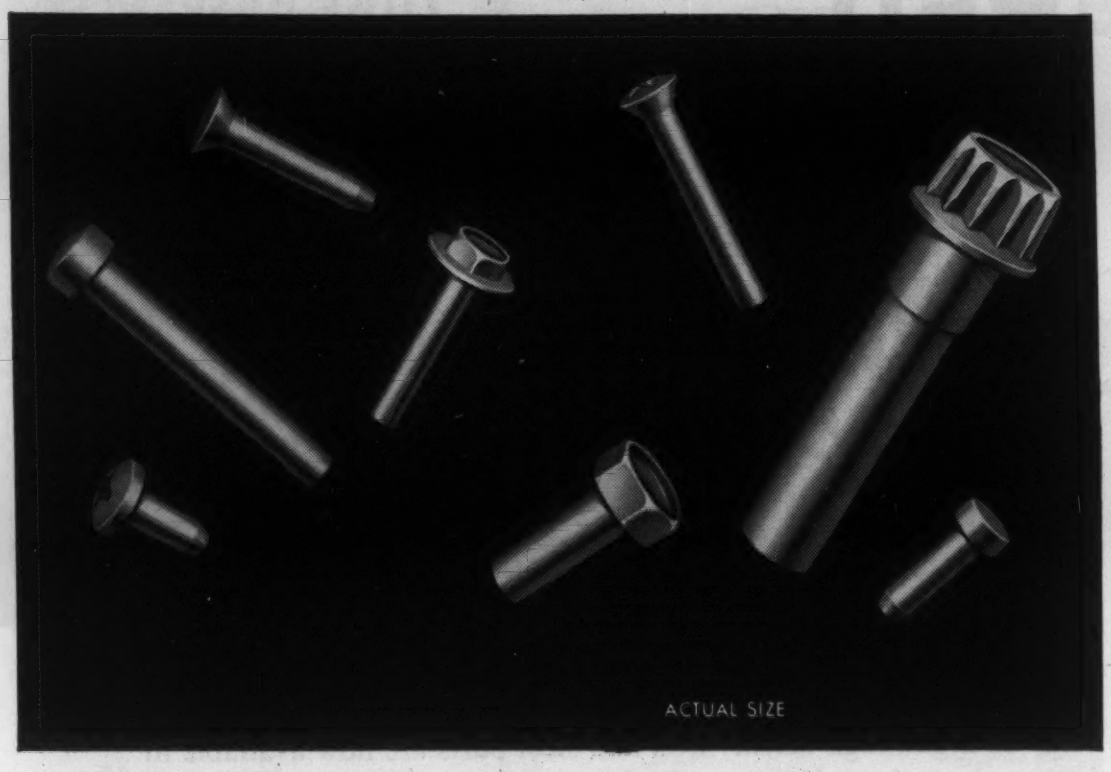
KEYSTONE XL COLD HEADING WIRE



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KEYSTONE WIRE for Industry

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CONTENTS NOTED

mandatory, it seems to improve reproducibility of results. The range of rubber compound formulations that can be bonded is unlimited. However, since most primer materials can be vulcanized or polymerized, some agreement should be found between transformation time of the primer and curing time of the rubber compound.

Bonding materials

Intermediate hard rubber—The usefulness of ebonite for rubber-metal bonding has been known for some time. A coat of ebonite compound solution is applied. When the solvent has evaporated, another coat of ebonite is applied and covered with a soft compound. The entire assembly is then vulcanized under pressure.

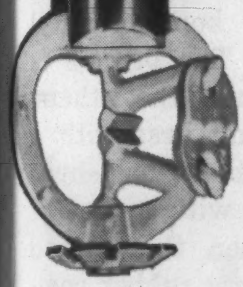
Adhesion is very good, but ebonite is brittle and cannot be used for parts which must resist shock or vibration. Also, since ebonite cures much more slowly than the soft compound, the latter is often over-cured, with resulting lower mechanical properties. This can be remedied somewhat by using delayed action accelerators or by prevulcanizing the ebonite.

Ebonite-bonded components are limited in use to temperatures below 150 F, since ebonite becomes thermoplastic at that temperature. Also, since there is a considerable difference in expansion rates between ebonite and metals, assemblies should not be submitted to sudden temperature variations.

Rubber derivatives—A number of derivatives of natural and synthetic rubber can be used as primer coats. Thermoprene is a hard resin, which in a rubber solvent solution can be applied to a metal surface. It provides good adherence to contact-vulcanized compounds. Its use is limited to temperatures below 160 F.

Chlorinated rubber can be used to bond compounds of neoprene and butadiene-acrylonitrile copolymers to metal. In certain cases, adhesion is improved by the addition of 20-30% red lead to the

Office with concealed piping, only the heads showing



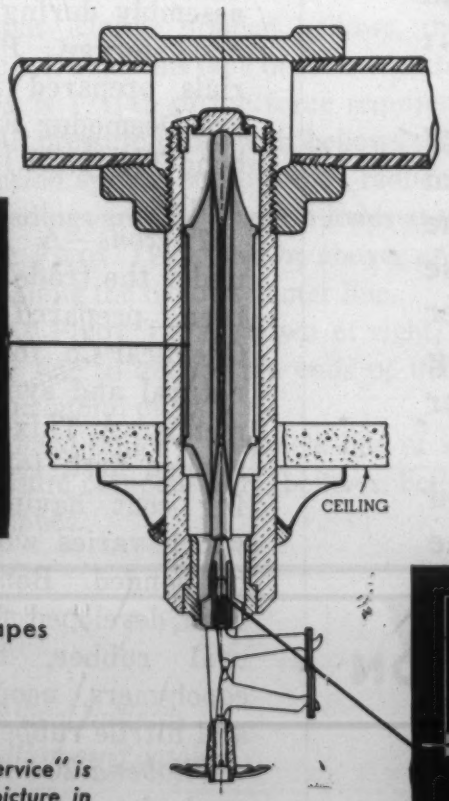
REVERE Extruded Shapes

in dry pendent sprinkler heads lessen machining, save money

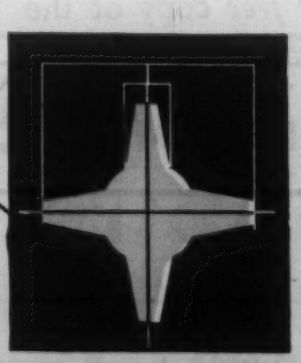
Some 16 years ago the Viking Corporation, Hastings, Michigan, decided to find a way to put sprinkler piping for dry pipe systems above the finished ceiling, leaving only the sprinkler heads visible. This meant designing a sprinkler head which would be free of water except when in use. Thus there would be no drainage problem, and no chance of freezing. The dry pendent sprinkler head as finally developed extends into the sprinkler pipe, where a bronze cap keeps the entire valve waterless. When a fire occurs the usual fusible element melts, two struts drop, releasing the cap and permitting water to flow.

In the original experimental work, the two struts were machined out of solid brass bar. This took time and involved the generation of a considerable amount of scrap, since each strut has four deep fins. Once the idea had proved itself, Viking came to Revere for extruded shapes, in order to save both machining and metal. So much time has elapsed since the original machining of the bar that comparative cost figures would be meaningless, but it is evident to Viking, and to everybody familiar with extruded shapes, that the saving is substantial.

Cross section of Viking Dry Pendent Sprinkler Head, and cutaway view



Outline of the two shapes supplied by Revere



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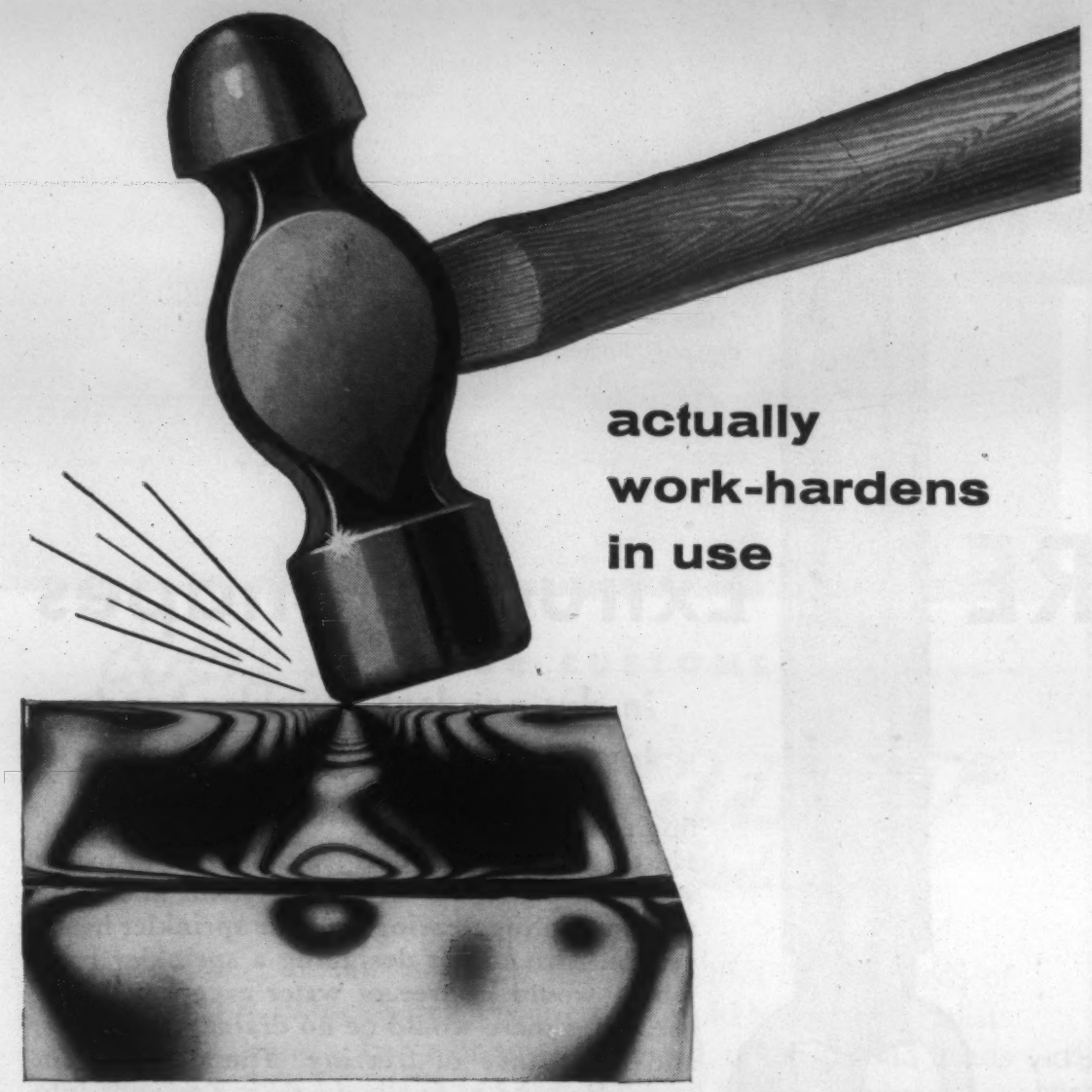

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Amsco manganese steel actually absorbs impact energy which work-hardens the metal's surface up to a maximum of 550 BHN, while below the surface (as shown by the photoelastic stress pattern in the illustration) manganese steel maintains its ductility. The more it's used, the harder and more polished the surface becomes. This self-polishing characteristic minimizes wear and reduces the need for frequent lubrication.

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AMERICAN Brake Shoe COMPANY

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CONTENTS NOTED

primer solution.

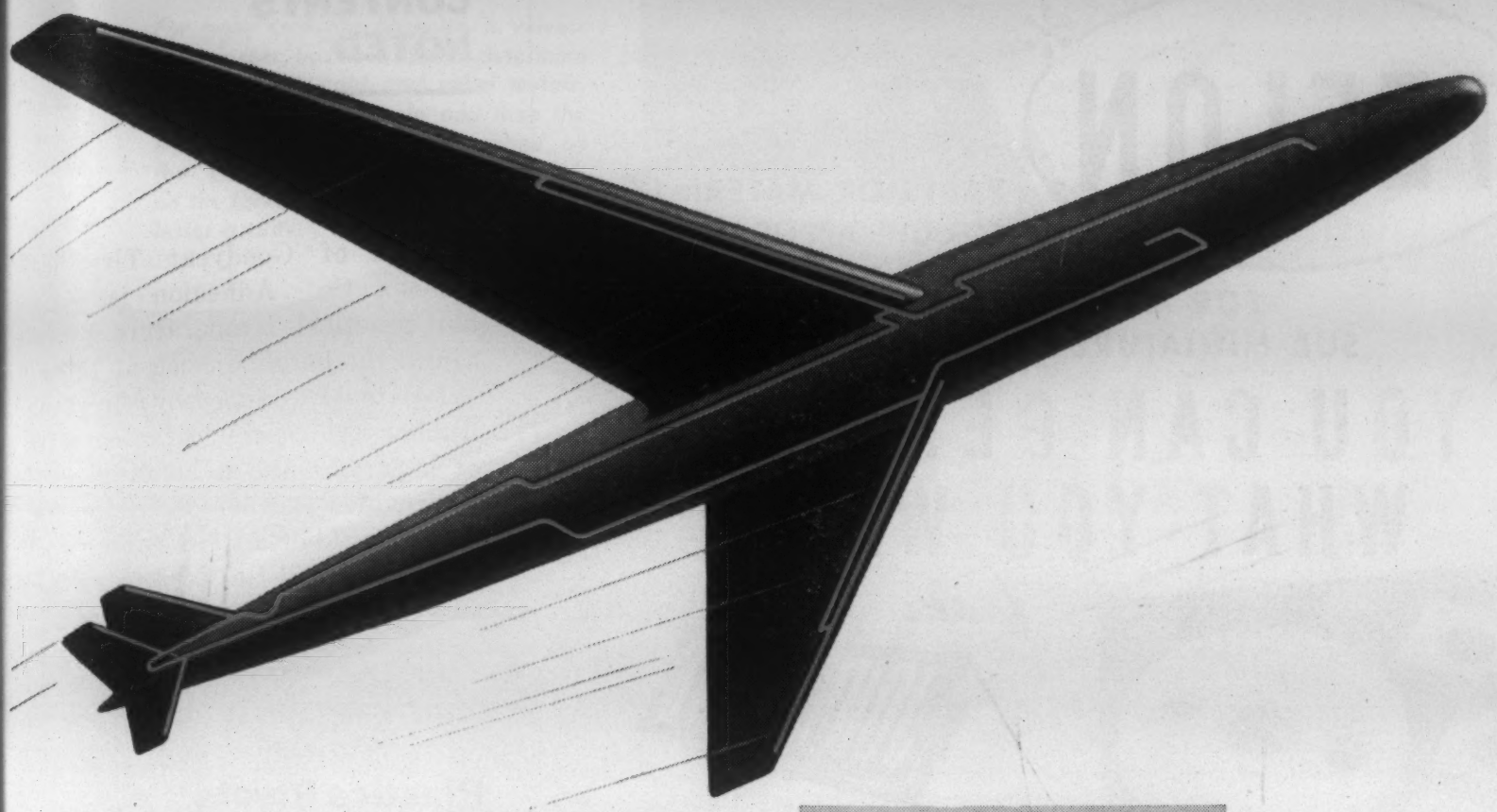
The Ty-Ply process, developed by Vanderbilt Co., makes use of rubber hydrochloride which, when dissolved in xylene, is used in the same way as chlorinated rubber. There are variations of this process for bonding natural rubber, butadiene-styrene copolymers, neoprene, and nitrile rubbers. Ty-Ply has better resistance than Thermoprene to temperatures up to about 212 F.

Hycar 2202, a butyl rubber containing bromine, has been developed recently by B. F. Goodrich Chemical Co. for bonding butyl rubber to metal. The process is more intricate than the others. It involves priming first with a coat of resorcinol-formaldehyde resin, and second with a coat of Hycar 2202. When this second coat is dry, the raw rubber compound is applied and vulcanized.

Polyisocyanates—Di- or triisocyanates provide most metals with excellent, simple bonds to any natural or synthetic rubber except butyl. Bond strength is generally higher than the specific strength of the compound, and the bonds resist temperatures up to 300 F. Special care must be taken to exclude moisture from the assembly during both application and storage. Proprietary materials prepared from isocyanates are Desmodur R (Bayer), Vulcabond TX (I.C.I.) and MDI-50 (Du Pont).

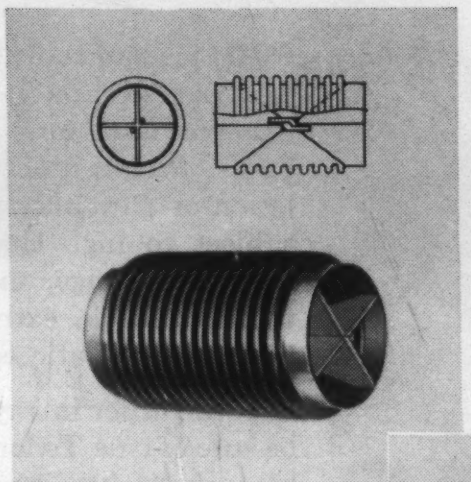
Thixons—A line of primers under the trade name Thixon has been prepared by Naugatuck Chemical Co. for bonding various natural and synthetic rubbers to metals. A Thixon primer coat is applied first, followed by a bonding coat having a composition which varies with the rubber to be bonded. Bonding coats have been developed for use with natural rubber, butadiene-styrene copolymers, neoprene, and butyl and nitrile rubbers.

Pliobond 20—A general product used for bonding synthetic or natural rubber compounds to a variety of metals, Pliobond is a

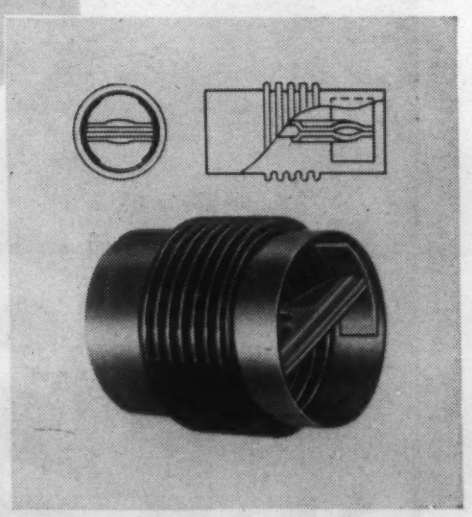


HOW TO STUNT THE GROWTH

OF THERMAL LOADS IN AIRCRAFT PNEUMATIC DUCTING SYSTEMS



Center link type bellows tie-rod available in all diameters from 1" to 8".



Double link bar type bellows tie-rod available in all diameters from 1" to 8".

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To Control or Absorb Thermal Growth of stainless steel ducting by angular deflection, Arrowhead bellows tie-rod assemblies offer the optimum for low force deflections. Unlike braided bellows, these tie-rod assemblies are internally restrained. Due to this type of restraint, the actual deflection force required, in many cases, is 1/10th of the force required with braided bellows. Although there is a small pressure drop*with bellows tie-rod assemblies, they have special value in a tension system because they reduce the bending moments . . . reduce the column loadings and the reaction loads at the mounting flanges.

Single Pivot Type, shown above, anchors the ends of the bellows at a single point along the bellows center line.

Double Pivot Type, shown at right, employs two pivot points on the bellows center line to anchor the ends of the bellows. This type is capable of absorbing some lateral offset.

Arrowhead builds a complete line of stainless steel ducting components including pressure compensators, bellows, bellows tie-rods, braided bellows, and ducting assemblies.

**Example:* Pressure drop at a flow of 120 lbs. per minute is 25" of water (3" I.D. duct with bellows 2½" long and 4" overall unit length).

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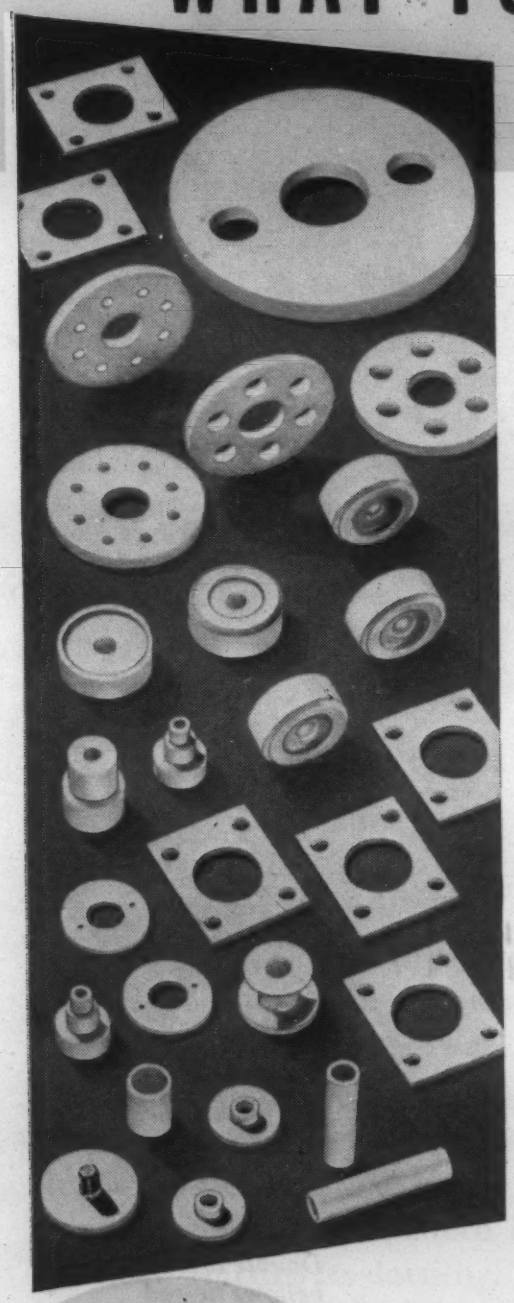

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product of Goodyear Tire and Rubber Co. Adhesion is good, but practical temperature limits are in the neighborhood of 140 F.

Loxite—Developed by Firestone Rubber Co., the process consists of a primer and a bonding coat. It provides excellent adhesion for natural rubber, nitrile rubber and neoprene bonded to ferrous metals and light alloys.

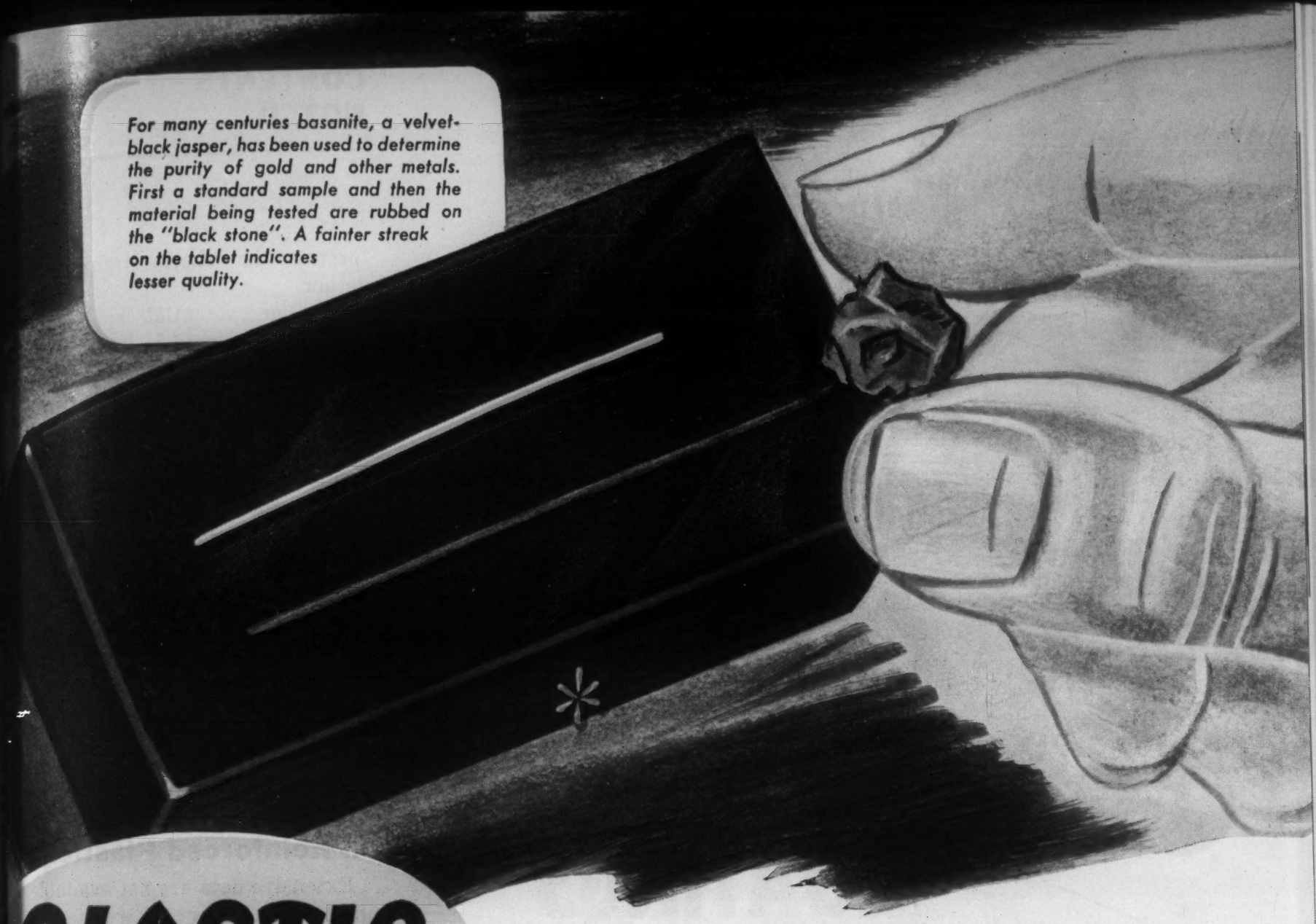
Plastics Rivets Join and Insulate

Rivets made of thermoplastic resins can provide an efficient method of joining metals. They offer particular advantages to the electrical manufacturing industry, since they can be used in many places where a fastener must serve as a dielectric. Methods of installing such fasteners and some advantages in their use are explained by O. W. Bangma in the April '55 issue of *Vrang en Aanbod* (Dutch).

The author describes how two metal plates can be both fastened and insulated by a plastics rivet. Two metal strips with pre-drilled holes are lapped with a pre-drilled sheet of insulating material between them. Thermoplastic rivets are then installed through the aligned holes, and the ends of the rivets heated and flattened. The two metal strips are thus completely insulated from each other.

One advantage of using thermoplastic rivets lies in the fact that the sheets of material being joined need not be held tightly together during riveting. Sheets to be joined with metal rivets must be held tightly together, since the rivets bulge almost uniformly over their length when compressive loads are applied. The heated end of the plastics rivet, however, is its softest part, and the applied load causes the hot end to bulge outward, forming a cone and

For more information, Circle No. 458



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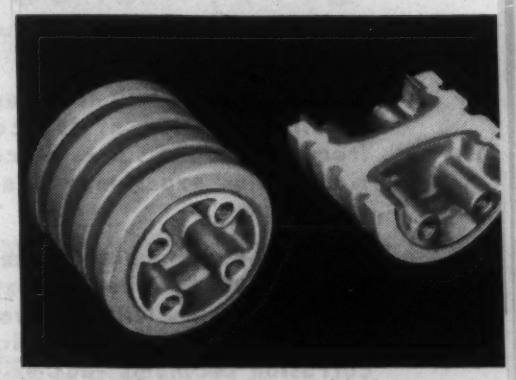
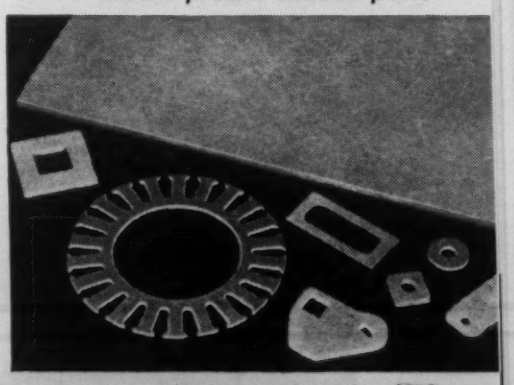
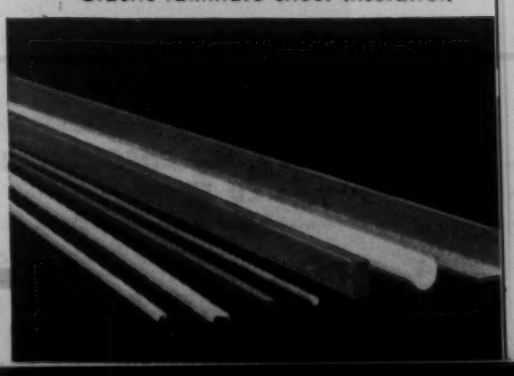


Glastic premix molded parts



Glastic laminate sheet insulation



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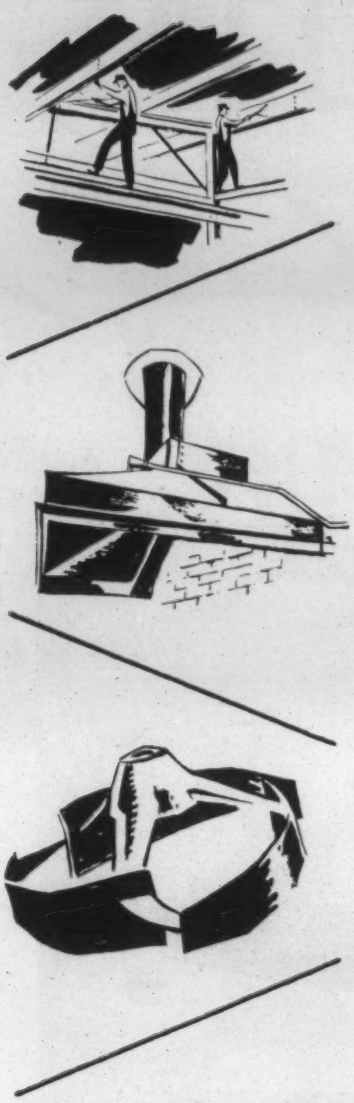

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ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN, PENNSYLVANIA

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forcing the sheets tightly together.

Another potential application for plastics rivets is leading one conductor through another without electrical contact between them. For this type of assembly, a rivet is first installed; then the conducting wire or strip is pushed through the center of the rivet so that it is completely insulated from the plate or sheet by the surrounding rivet material.

(Adapted from a digest appearing in the Jan issue of *EPA Technical Digests*, distributed by the Organization for European Economic Co-Operation.)

Effect of Water on Reinforced Plastics

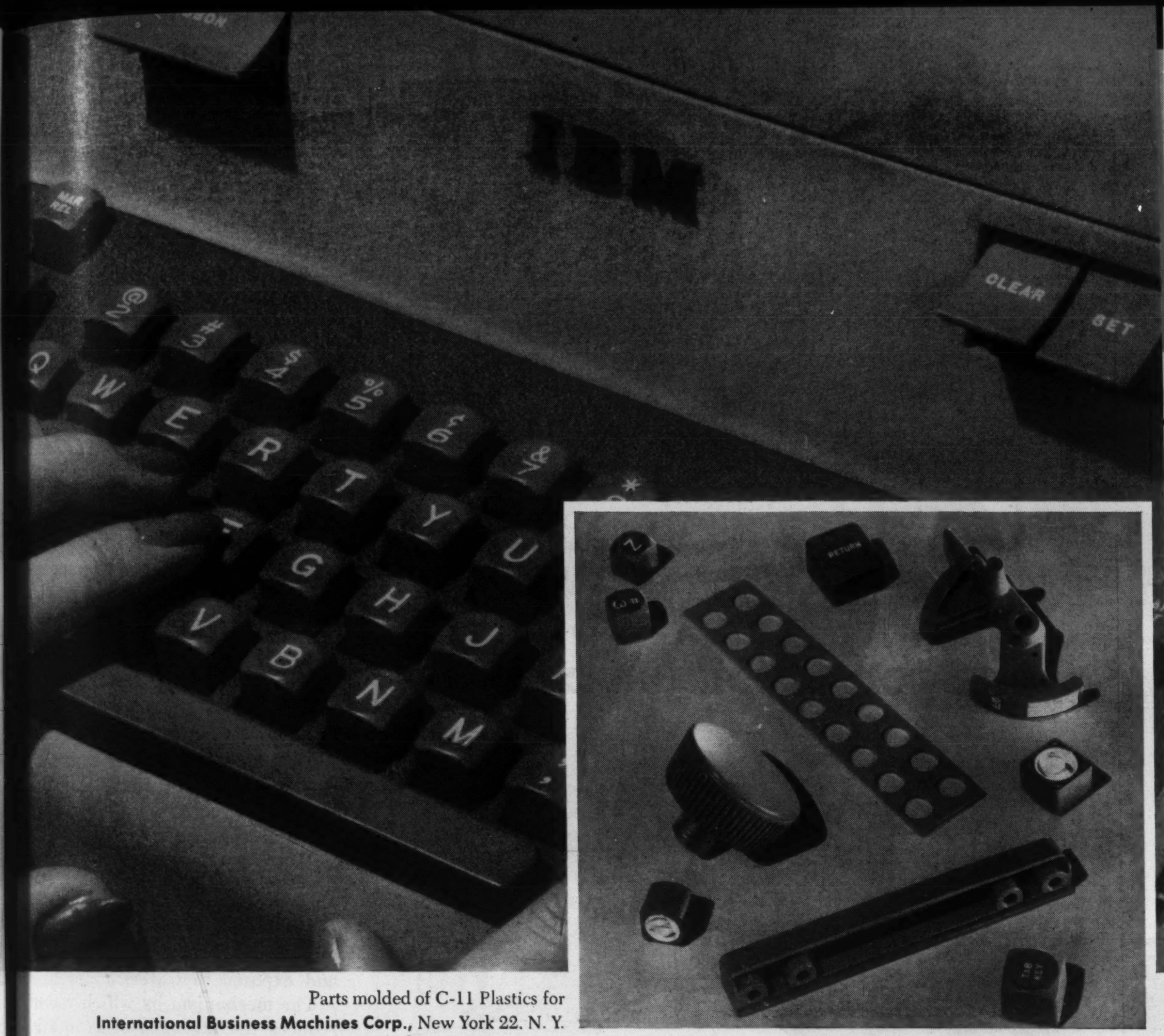
Extensive data are not available on the behavior of reinforced plastics under load in environments of intended use. Although creep tests under constant load have been made on reinforced thermosetting resins, none of the tests have been made in environments other than air. Yet it has been shown that wet strength values obtained by testing in air can differ radically from those obtained by testing in water.

In order to obtain environmental data not presently available, Shell Development Co. established a laboratory project to determine the performance of polyester-glass and epoxy-glass laminates under load in water. W. H. Sharp and M. K. Weber report some of the results of this project in the February issue of *Corrosion*.

In general, they found that strengths of all glass-reinforced polyester or epoxy laminates examined were reduced appreciably by exposure to water. The weakening seems to result from deterioration of the resin, the glass and the glass-resin bond.

Effect on resins

The authors point out that there are three factors which exert a large influence on wet strength of resins: type of resin,



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key buttons, platen knobs, space bars, and switch levers

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CONTENTS NOTED

type of curing agent and curing cycle.

For example, the amount of water absorbed depends on the type of resin, as well as time of immersion. The polyester resins tested absorb water rapidly during initial stages of immersion and, as a result, are weakened rapidly. On the other hand, constant load flexural deflection measurements of unreinforced strips of one of the most water resistant epoxy resins available indicate that, although even this resin is appreciably weakened by water, the effect is not as rapid or as great as on other resins tested. In general, tests on these and other resins show that the presence of water affects the load-carrying abilities of different resins to different degrees.

The authors also found that variations in curing agents and curing cycles have a strong effect on wet strength. However, the most favorable resin, cured with the most favorable curing agent and with optimum curing cycles, still weakens appreciably when loaded and exposed to water.

The mechanism by which water reduces the strength of resins is not understood. It appears probable, however, that the change in the resin is of a physical nature, with the water acting as a plasticizer or internal lubricant for the movement of the large resin molecules.

Effect on glass

Though glass is generally considered to be a stable, inert material, there is considerable evidence that its strength is greatly affected by water. For example, Baker and Preston have shown that Pyrex glass rods are 2½ times stronger in vacuum than they are after exposure to water vapor at atmospheric pressure. Also, long term strength of glass in contact with water vapor is considerably less than short term strength, indicating a continuing decrease in the strength of glass under constant load when exposed to water.

Glass-resin laminates made by

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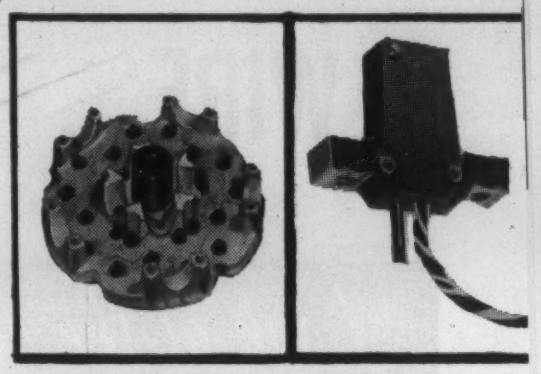

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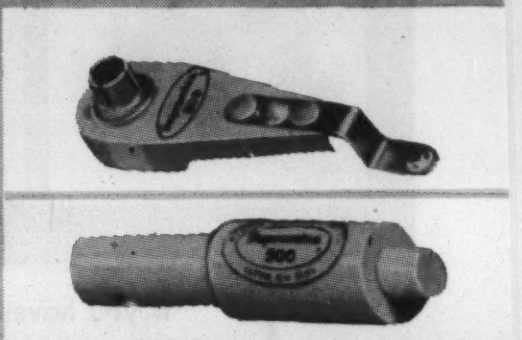
TYPICAL APPLICATIONS



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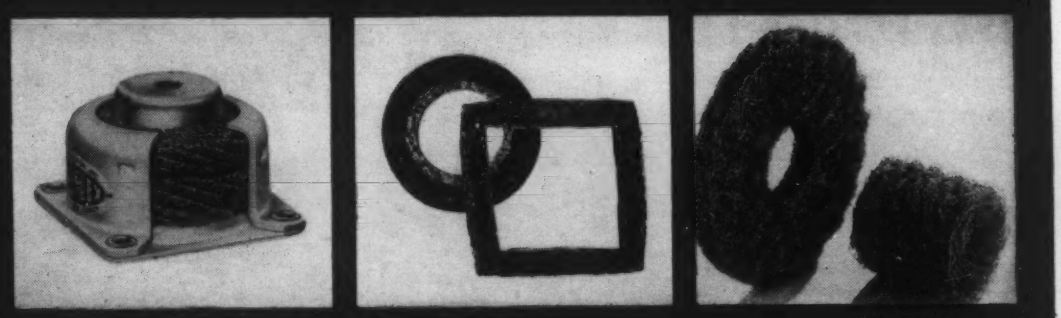

If you haven't started to investigate the design potential for knitted stainless steel and nickel alloy wire, now is the time to do it. Here are some interesting applications to whet your interest and imagination:

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Many other industrial applications take advantage of the outstanding properties of knitted alloy wire. Learn more about these interesting products . . . send today for Application Bulletin A-1.

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H. K. PORTER COMPANY, INC.
Prospect Park, Pennsylvania

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CONTENTS NOTED

applying resins directly to glass have poor wet strength. To the extent that this poor strength is not accounted for by the effect of water on the resin, it can be attributed both to weakening of the glass and to deterioration of the glass-resin bond.

Many types of glass finishes or coupling agents have been developed to improve this bond. Thin films of such finishes are designed to provide molecules having active groups at each end which will bond both to the glass and to the resin. Reports on relative wet strength of polyester resin laminates made with various glass finishes indicate that considerable improvements have been made. Although a great deal of the work has been directed toward providing improved finishes for use with polyester resins, experimental chlorosilane finishes reported recently are said to provide good results with epoxy and phenolic as well as polyester resins.

New Abrasion Tester for Porcelain Enamels

A simple, rapid device for determining the abrasion resistance of porcelain enamels has been developed by the National Bureau of Standards. The instrument is believed to provide a reliable means of testing a variety of enamel finishes including "orange peel" and wavy surfaces.

Designed primarily for porcelain enamels, the device can also be used to determine wear resistance of such other materials as plastics, fibrous materials and organic finishes. The instrument and test method were devoloped for the Porcelain Enamel Institute by G. Warren and J. H. Giles, PEI research associates at the Bureau.

How test is run

The machine consists essentially of a motor-driven table gyrating in a horizontal plane at 300 rpm. The table moves parallel to itself and describes a 7/8-in. dia circle. Nine specimens, each

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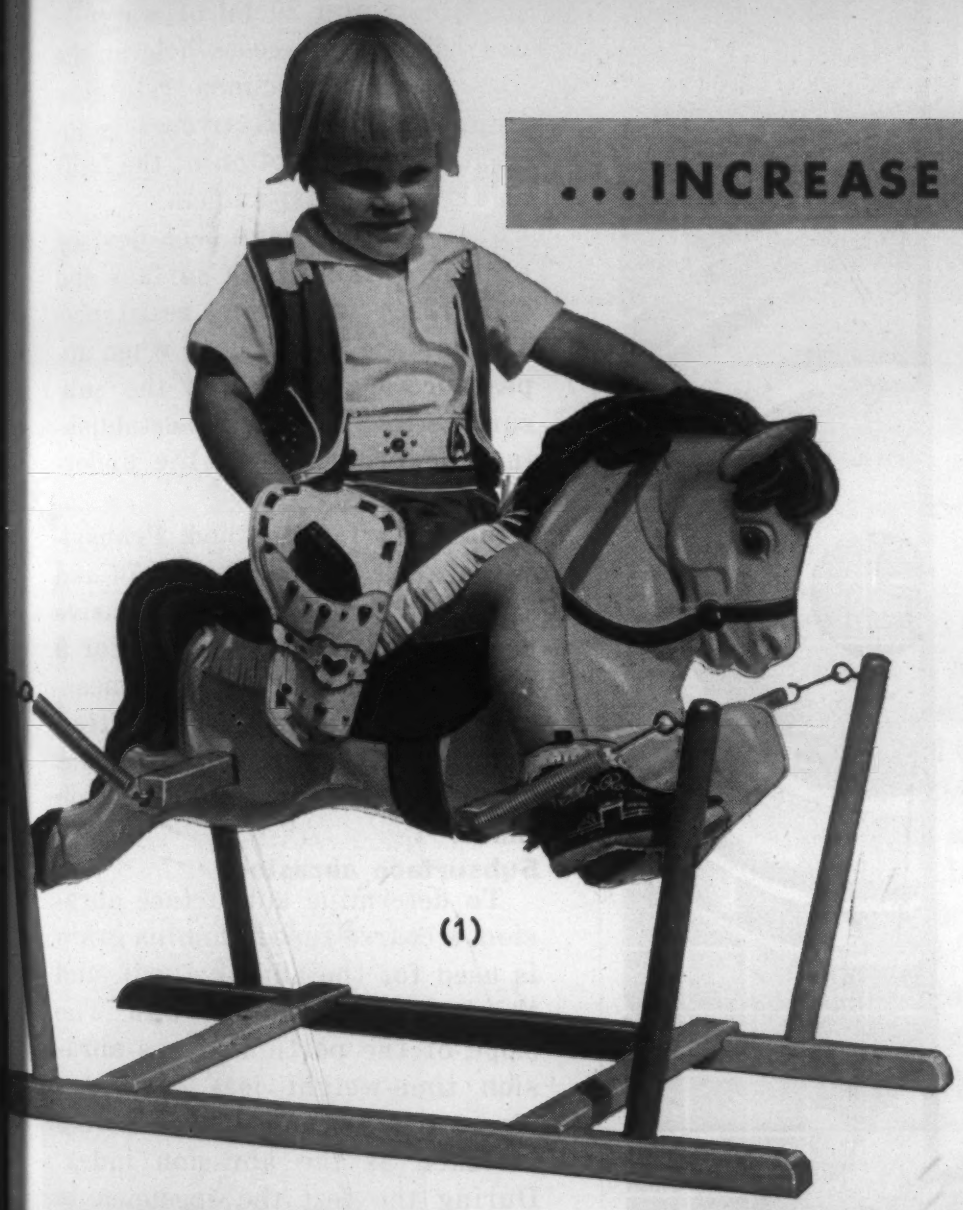

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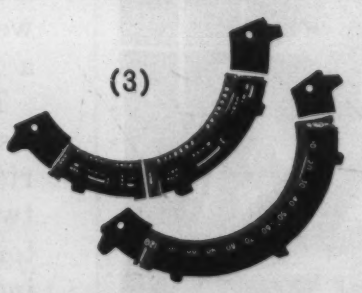

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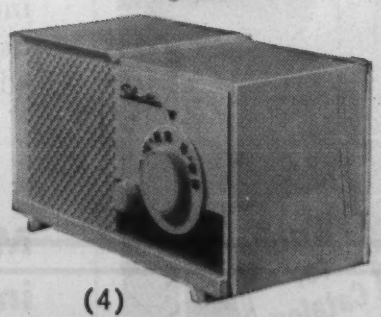

(4)

Pictured at left: (1) Delphos Springing Horse, (2) RCA Color TV Mask, (3) Altorfer Washer and Dryer Dials, (4) Arvin Radio.

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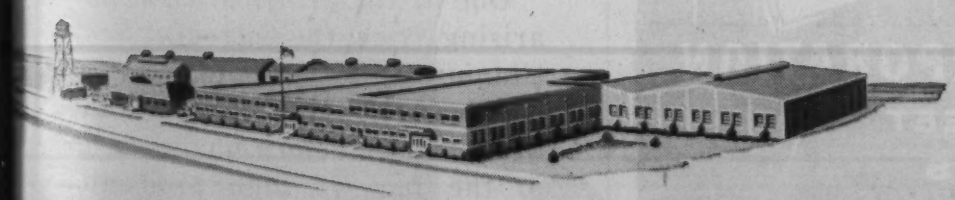

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4½ sq. in. in area, can be tested simultaneously. An abrasive charge consisting of 3 gm of abrasive grit, 175 gm of 5/32-in. stainless steel balls and 20 ml of water is poured into an access hole at the top of each specimen retaining ring. Abrasive effectivenes is increased by the motion of the balls on the moving specimen.

Test methods have been devised for determining both surface and subsurface abrasion resistance. The surface test is used when appearance is important; the subsurface test is used for establishing the protection of the underlying metal.

In the surface method, Pennsylvania glass sand, between 70 and 100 mesh, is used in the abrasive charge, and the test is run for 5 min. The specular gloss is measured before and after the test, and the percentage retained gloss at 45 deg is the surface abrasion index.

Subsurface abrasion

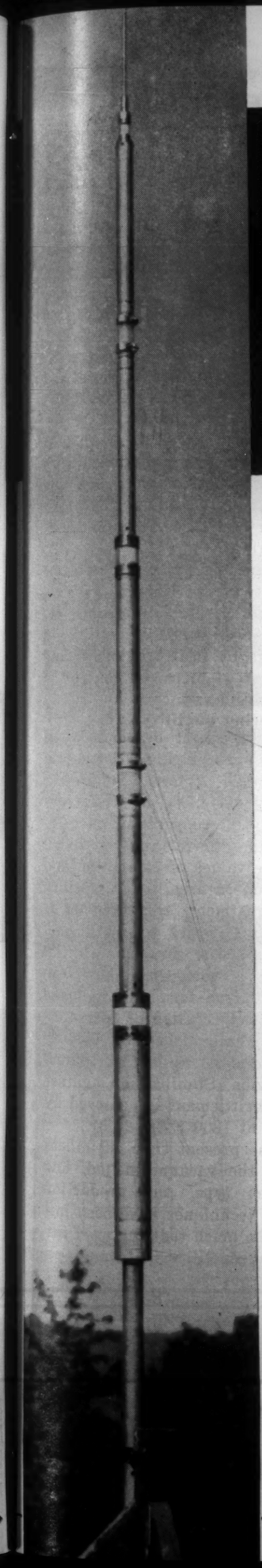
To determine subsurface abrasion, a coarse fused alumina grain is used for the abrasive grit, and the test is run for 45 min. The slope of the portion of the abrasion time-weight loss curve between the 15- and 45-min points is taken as the abrasion index. During the test the specimen is weighed at 15-min intervals and a fresh abrasive charge inserted.

Tests of several porcelain enamels at four cooperating laboratories have demonstrated that the two test methods give satisfactory reproductibility, and that the indices of abrasion resistance obtained are in general agreement with service experience.

Making Titanium Work in Turbojets

One of the principal challenges arising from the introduction of titanium into turbojet engines has been the difficulty in maintaining satisfactory quality levels in the face of high production

For more information, Circle No. 527



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SHELBY SEAMLESS TUBING
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provides high strength and corrosion resistance for coaxial antenna

The Type 3006 Coaxial Colinear Antenna*, consisting of three half-wave vertical dipoles arranged colinearly and operating on a frequency range of 152-176 MC, is especially suitable for patrol car broadcasting. The three vertically arranged dipoles exhibit a gain of 5 to 6 db over a standard single dipole, and produce a low angle of radiation with equal radiation in all directions.

This 13½-foot, 40-pound antenna is supported by a mast made of Shelby Seamless Tubing (USS Stainless Steel) running through its center. In addition to possessing the tensile strength to withstand 100-mile-per-hour winds, this stainless supporting mast has high corrosion resistance—will not flake from oxidation and cause short circuits.

In such critical applications where superior strength, uniformity, dimensional accuracy and corrosion resistance are needed, Shelby Seamless Tubing of USS Stainless Steel is consistently chosen to meet the requirements. Shelby Seamless Tubing, available in a wide range of diameters, wall thicknesses, various shapes and steel analyses, is produced to exacting standards by the world's largest manufacturer of tubular steel products. If you wish, our engineers will make a study of your requirements, and will help you apply Shelby Seamless Steel Tubing to your specifications.

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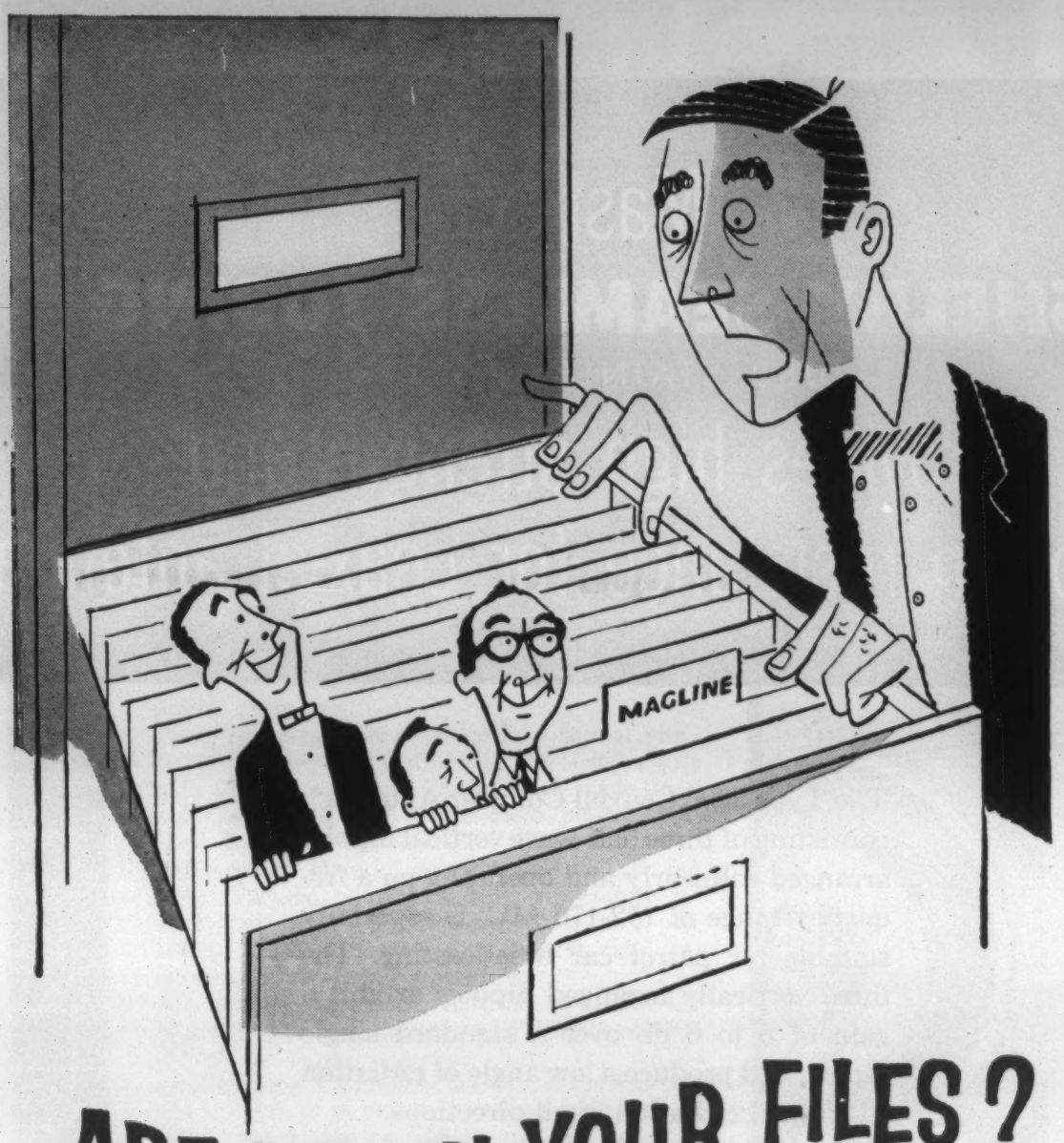

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rates. It is pretty well established that the properties of this metal are such that it requires manufacturing processes and methods quite different from those used with other metals.

In a paper presented before the annual meeting of the Society of Automotive Engineers last January, J. L. LaMarsa and J. L. McCabe of General Electric outlined their company's experience with the introduction of production quantities of titanium alloys (C-130AM and Til40A) into turbojet engines.

Among the principal problems encountered have been procurement of acceptable forgings, recovery of adequate ductility in forgings by heat treatment, and reduction of hydrogen content to acceptable levels.

Recovering ductility

During initial development it became apparent that a large percentage of forged compressor discs would have unsatisfactory ductility. To convert low ductility forgings into forgings with acceptable values of elongation and reduction in area, a satisfactory heat treatment, composed of a descending series of isothermal plateaus, was evolved. Initial heating is somewhat above the complete transformation temperature. Reciprocation of coarse alpha is accomplished by holding for several hours in the isothermal region. Stabilization against age embrittlement is achieved by holding at 1200 F for 24 hr.

At the present time, all billets are of the vacuum melted, low hydrogen type, and production forging techniques have been improved so much that the need for restoring ductility in forgings is rarely required.

Effects of composition

Commercially pure and low alloy grades generally are obtained from various grades of sponge. Higher strength alloys, however, are produced by additions of ferrochrome, ferromolybdenum, electrolytic manganese and aluminum. The most desirable high

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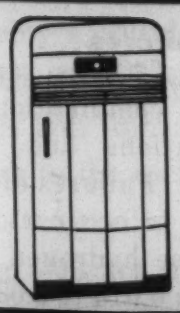

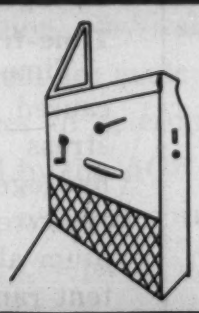

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CONTENTS NOTED

temperature strength properties in titanium alloys are attained by adding metallic elements rather than by using lower grade sponge and adding interstitial elements such as oxygen and nitrogen. For example, at 700 F the strengths of the high oxygen nitrogen and low oxygen nitrogen grades are only 50 and 25% of their respective strengths at room temperature.

Interstitials in excessive amounts also affect the impact properties of titanium alloys. A good straight line inverse correlation has been found between carbon content and room temperature V-notch Charpy impact strength in aluminum-manganese alloy C-130AM. Values show a drop from 2.25 ft lb with 0.06% carbon content to 2.0 ft lb with 0.32-0.36% carbon.

The effects of oxygen in the presence of other interstitials, such as nitrogen, hydrogen and carbon, on the mechanical properties of a series of iron-chromium alloys were studied. It was found that: 1) the increase in strength achieved by oxygen plus nitrogen additions is accompanied by a loss in ductility, 2) ductility becomes highly directional with increasing oxygen and nitrogen content, 3) interstitials drastically reduce impact energy absorption, and 4) interstitials are ineffective as elevated temperature strengtheners.

Time-fracture failures

Time-fracture failures can be caused by the combination of stress concentrations and high hydrogen content. Failures of this type were found to occur in titanium alloys whose hydrogen content ranged from 0.015 to 0.035%. Until 1955, the effect of hydrogen on the properties and stability of titanium alloys was not clearly understood. As early as 1949, users of commercially pure sheet were experiencing extremely high rejection rates. Failures took the form not only of immediate fractures in the dies, but also of time-fracture failures in finished stores

CONICAL MANDREL BENDS A SAMPLE. Diameter of bend varies from ⅛ in. to 1½ in.—determines adhesion quality of painted finish under bending stresses.

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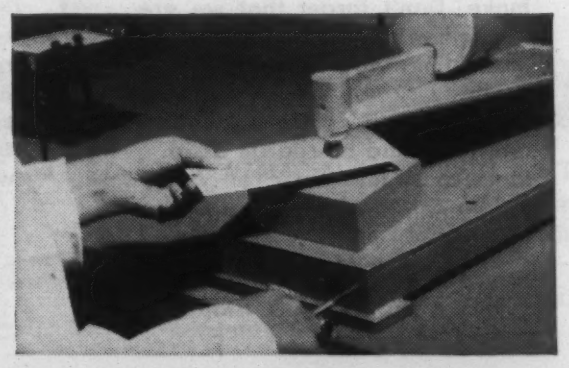
Behind the operation of an ACP process in your plant is an efficient Quality Control organization. Physical tests of production-run panels processed in your equipment are made on such devices as conical mandrels and impact machines to determine the adhesion of the painted finish to the metal treated by the ACP process in use. Other equipment tests weathering qualities, rust and corrosion resistance, abrasion resistance—all are part of the complete ACP customer service.

Ask us for more information about ACP processes for treating aluminum, steel, zinc, brass, copper and other metals, either for protecting the metal or producing a bond for decorative and protective paint finishes.



IMPACT TESTER STRIKES A TELLING BLOW . . . indicates the ability of the painted finish to resist cracking when metal is deformed by a steel ball under a predetermined impact.

AMERICAN CHEMICAL PAINT COMPANY, Ambler 15, Pa.

DETROIT, MICHIGAN NILES, CALIFORNIA WINDSOR, ONTARIO

CHEMICALS ACP PROCESSES

For more information, turn to Reader Service Card, Circle No. 510

CASE HISTORY 1

REQUIRED:

A dependable supply of this small, machined electrode to meet customer's quality and quantity needs at reduced cost.

HASSALL SOLUTION:

Hassall-designed re-heading process, involving no critical dimension changes, resulted in a 59% cost reduction to customer.

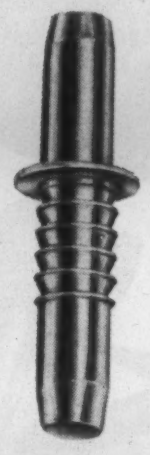
CASE HISTORY 106

REQUIRED:

Replacement for stud with insufficient head to act as stop for automatic hammering.

HASSALL SOLUTION:

Substitution of Hassall cold-headed collar stud with annular threads for greater holding power. Substantial cost savings.



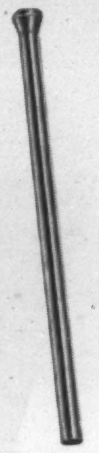
CASE HISTORY 64

REQUIRED:

An economical method of manufacturing perforating punches out of hard materials such as drill rod.

HASSALL SOLUTION:

The Hassall cold-heading process plus engineering skill overcame the difficulties presented by these alloys at considerable savings.



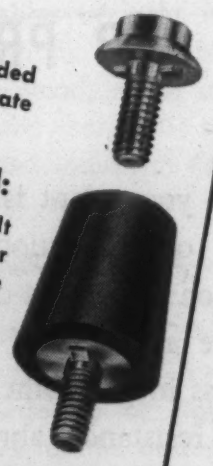
CASE HISTORY 37

REQUIRED:

Bumper bolt with bonded rubber cap for license plate support.

HASSALL SOLUTION:

The large head on this bolt would ordinarily call for screw machining but the two lugs under the head ruled this out. Progressive cold-heading was Hassall's answer.



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CONTENTS NOTED

or in service. These difficulties were attributed to high carbon content, and to surface hardening caused by oxygen absorbed during interpass anneals.

Investigations revealed that a combination of operating stresses and temperatures with a hydrogen content in excess of 0.015% could result in failures, particularly in parts with stress concentrators. The effect of hydrogen in developing brittle failures increases as the temperature is lowered. Conversely, the influence of hydrogen in promoting brittle failures decreases rapidly as temperatures increase above 250 F.

To reduce the hydrogen content to acceptable levels it was decided to vacuum anneal all parts containing above 0.015% hydrogen. Acceptable hydrogen levels were obtained by heating compressor discs in a retort for 24 hr at 1225 F under a vacuum of one micron. This treatment reduces the hydrogen content from a maximum of 0.035 to less than 0.0125%, with substantial increases in elongation and reduction of area.

Overspecifying Finish Can Be Bad Mistake

It has long been believed that, generally, the finer the finish, the better the fit on mating moving parts. This is not always the case.

Laboratory test results, when considered in the light of actual manufacturing experience, often lead to the inescapable conclusion that there is no universal method of specifying or obtaining the best surface finish for a given application. In the case of a moving part, the purpose of a finish specification is to permit the mating surface to reach a correct operating fit in the shortest time with minimum wear. The proper finish depends not only on the materials used, but on such factors as uniformity during manu-

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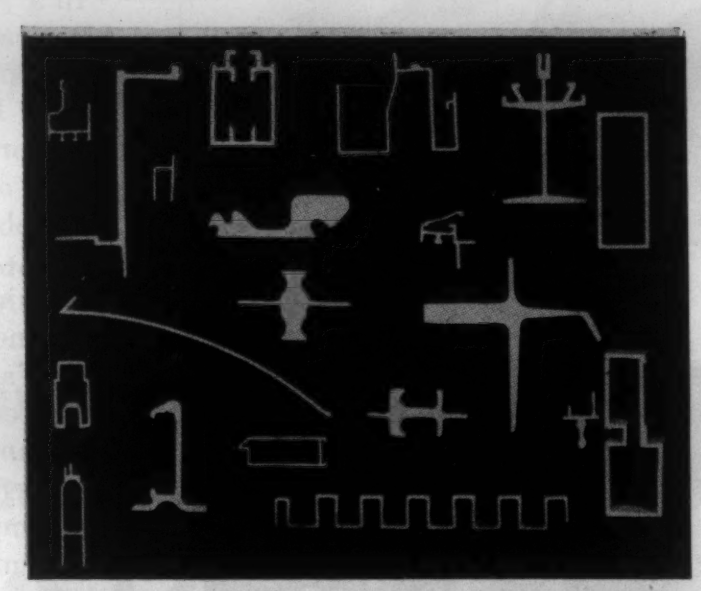
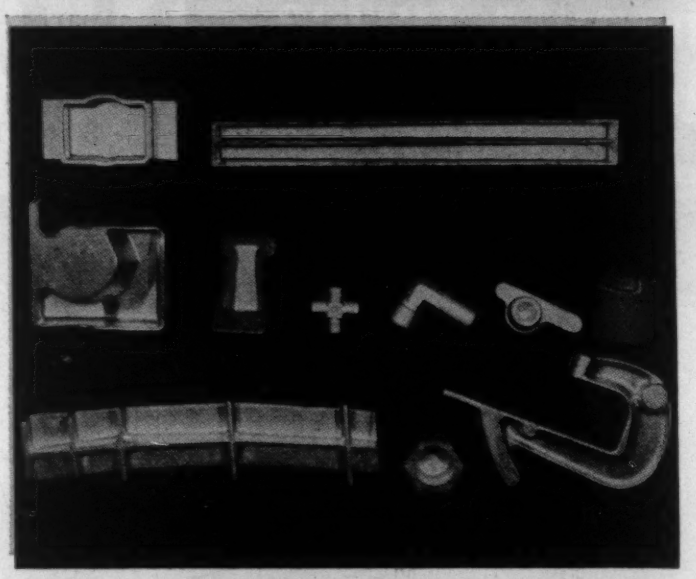
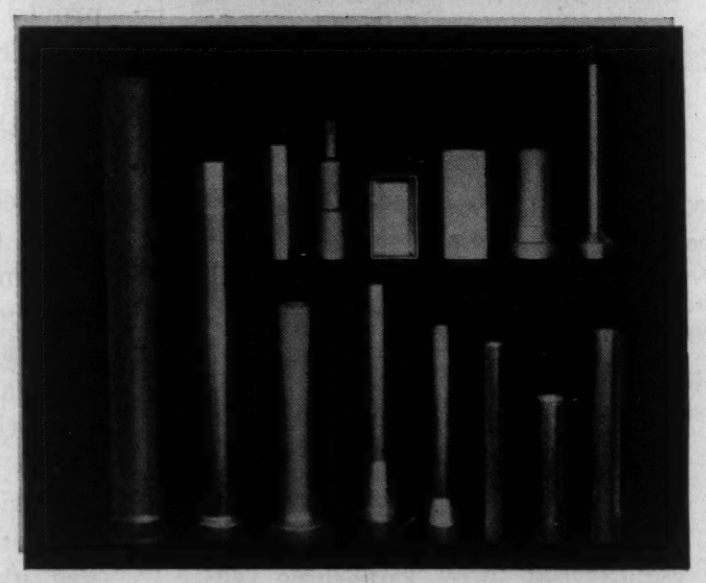


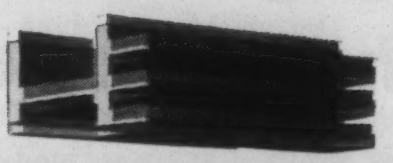
EXTRUSIONS . . . For decorative as well as basic parts, custom-designed aluminum extrusions replace riveted and welded assemblies . . . simultaneously adds strength, simplifies fabrication.



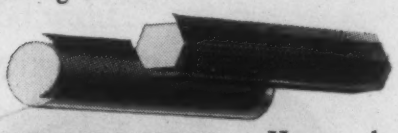
PRESS FORGINGS . . . Where parts must combine maximum strength with savings in weight, cost and manpower, Harvey aluminum forgings often completely solve the problems encountered by the designer.



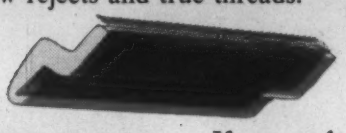
IMPACT EXTRUSIONS . . . Thin-walled, tubular structures can be produced by this method and held to very close tolerances. Machining is practically eliminated; scrap is greatly reduced.



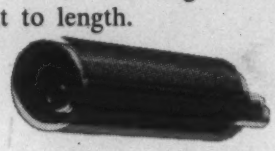
STRUCTURALS . . . High strength, light weight, workability, corrosion resistance. Aluminum extrusions combine all four . . . are ideal as basic load-bearing members.



MACHINING STOCK . . . Harvey deep-drawn hex and round stock set a new mark in uniform grain structure—consistent from surface to core. This means fast, chatter-free cutting, long tool life, few rejects and true threads.



FORGING STOCK . . . If you make your own forgings in quantity, Harvey extruded forging stock can save many intermediate steps. Custom-designed extrusions whose cross sections approximate the forged blanks may be cut to length.



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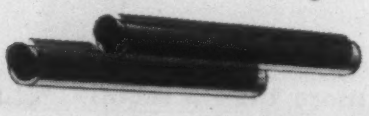

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CONTENTS NOTED

facture and actual operating deflections and tolerances.

In a paper presented before the American Society of Tool Engineers in March, Dr. C. R. Lewis and A. L. Thomson, of the Chrysler Corp., described the current status of surface finishes in the automobile industry.

Laboratory vs service

Considerable experimentation with and study of various degrees of surface roughness dramatically indicated that increased surface smoothness would greatly improve the performance of moving parts. To implement these findings superfinishing of critical moving parts was specified as follows: 5 to 25 microin. for piston skirts, 4 to 6 microin. for brake drums, 3 to 12 microin. for cam contours, and 2 to 4 microin. for tappet barrels and heads.

The disparity between these specifications, which grew out of laboratory tests, and actual service conditions soon became evident. During service, the break-in period should be a time of relatively high wear to provide true mating between moving parts. The break-in period with fine surfaces proved to be somewhat longer than the time allowed for the customary judicious break-in, however, with the result that pistons, tappets and cams sometimes became scuffed.

In contrast, when increased roughness was allowed on critical surfaces, higher initial wear rates provided mating surfaces with adequate smoothness for stable operation. As a result, piston skirts are now left in the turned condition with a roughness specification of 60 microin. max, cams are ground to 20 microin. max, and tappets are ground to 12 microin. max and lubricated for additional wear protection during break-in.

Character of finish

The character of the surface left by the finishing operation is also of vital importance. If both mating surfaces are characterized by a succession of plateaus with

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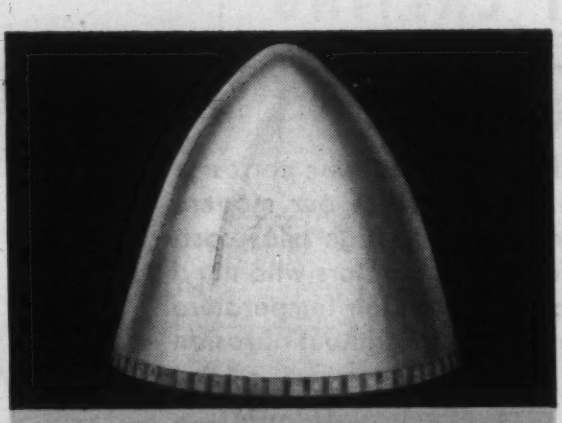
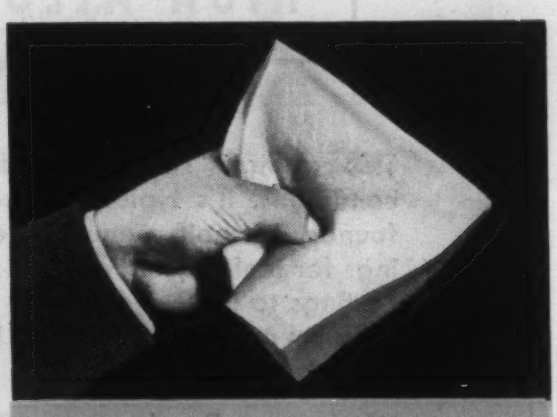
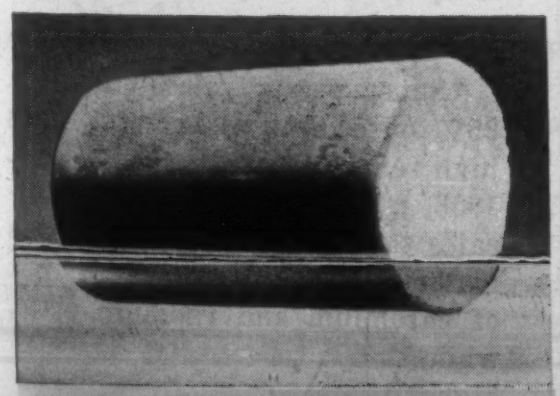


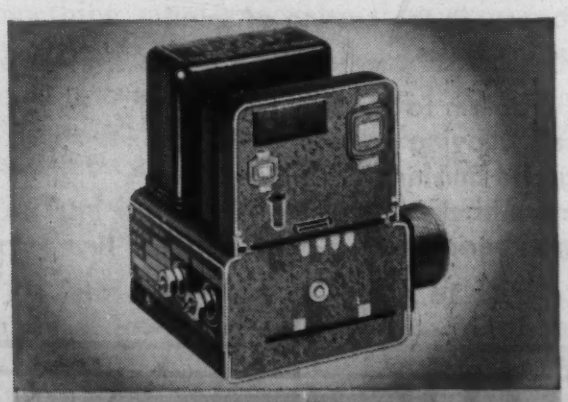
NEAR PERFECT RADAR TRANSMISSION! Nopco Lockfoam is the most widely accepted core material for aircraft and guided missile radomes.



FLEXIBLES WITH BUILT-IN SAFETY! Because of its "dead" characteristics and high energy absorption properties Lockfoam is ideally suited for automotive crash pads, helmets, packaging and shock mountings.



LOCKFOAM FLOATS! Lockfoam's unicellular construction provides excellent buoyancy and yet is unaffected by such liquids as gasoline, greases, aromatic solvents. Displacement varies inversely with changes in density.



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CONTENTS NOTED

depressions in-between, they show good bearing area, heat dissipation and wear debris accumulation. This is the desirable condition for long surface life. Superfinishing provides this surface condition; however, it does not provide a true mating contour unless design and manufacture are especially favorable. Conventional machining operations leave jagged profiles which are knocked off during break-in to form desirable, intimate mating surfaces.

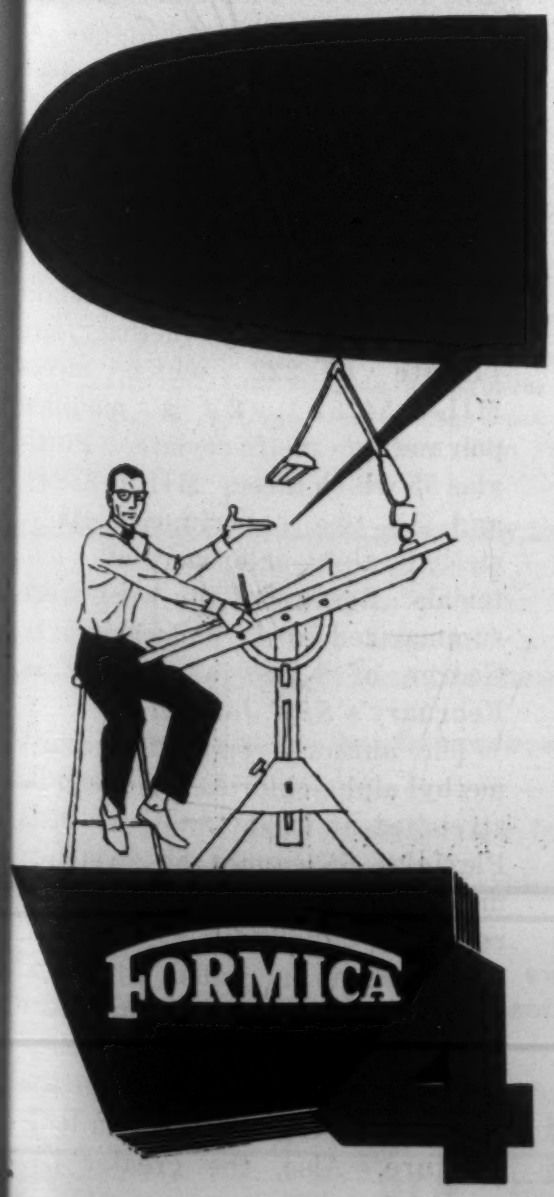
Piston pins are another example that points up what can happen to initially severe finishing requirements. A few years ago pins carried a specification of 1 to 2 microin.—a costly and troublesome demand to satisfy in production. Subsequent experience showed that this stringent requirement could be relaxed without sacrificing service performance, and today pins are lapped to 6 microin. max.

It is interesting to note that specification of the finishing operation does not necessarily specify the roughness produced. Specification of an acceptable roughness range is in many cases a safer rule. For example, though rocker shafts are finished by the same methods as the piston pins mentioned above, they end up with a rougher (yet still satisfactory) finish of 25 microin.

Super Purity Aluminum Shiniest of Metals?

"Super purity" aluminum (99.99% pure) is well known for its high reflectivity (see M&M, June, 1953, p 110). Recent work indicates that the specularity of this material is comparable with that of chromium and rhodium plate, while total reflectivity is much higher.

In an article appearing in the January issue of *Electroplating and Metal Finishing*, F. A. Champion and E. E. Spillet point out that magnesium can be alloyed with super purity aluminum to



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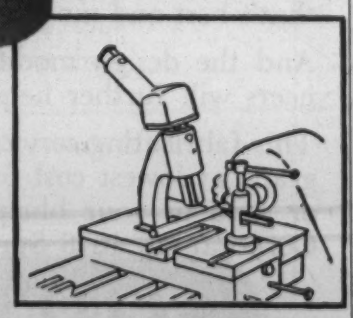

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give a harder and stronger meta without affecting reflectivity However, if magnesium conten rises above 1½%, reflectivity i reduced and anodizing difficulties may be encountered.

Anodized super purity aluminum affords superior weathering properties even when the anodic film is only 4μ thick. However, it has been shown that in severely corrosive environments there is a possibility of local perforation of the thinner films after prolonged exposure. Minimum film thicknesses recommended are 5μ for interior work and 15μ for films exposed to weather.

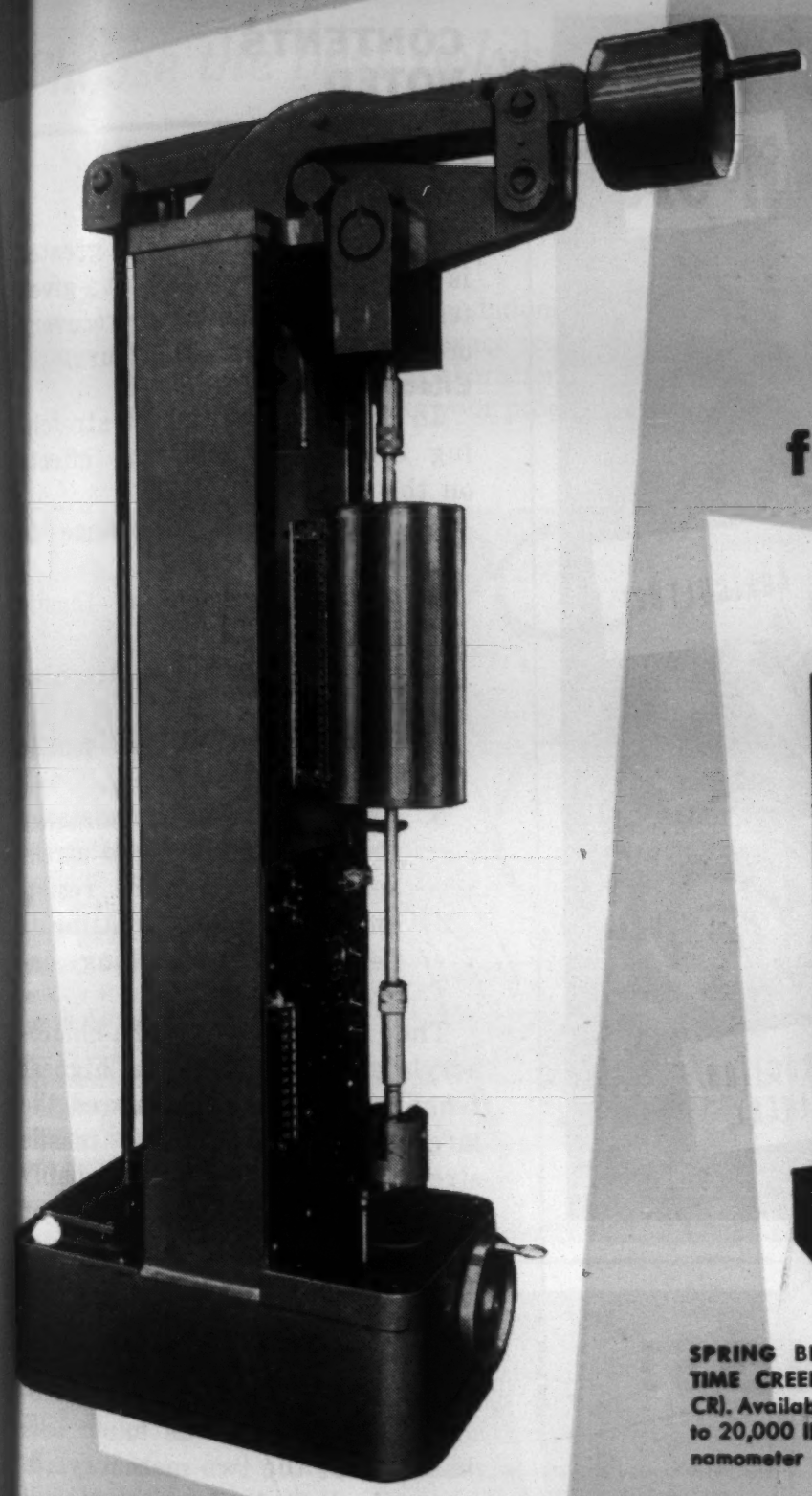
How Prestressing Affects Acrylic Sheet

Previous work has shown that multiaxial stretching of polymethyl methacrylate plastic sheet improves shatter characteristics and increases resistance to crazing. Use of this technique of orientation was recently extended by the National Bureau of Standards to several new transparent plastics which have improved resistance to heat and crazing. These materials are 1) an ultraviolet-absorbing, heat resistant grade of polymethyl methacrylate (Lucite HC-222, which meets MIL-P-5425A), 2) a modified polymethyl methacrylate (Plexiglas 55 which meets MIL-P-8184), and 3) two experimental polymethyl alpha-chloroacrylate materials. Results of the work were summarized by I. Wolock and D. George of NBS in a paper in February's *SPE Journal*.

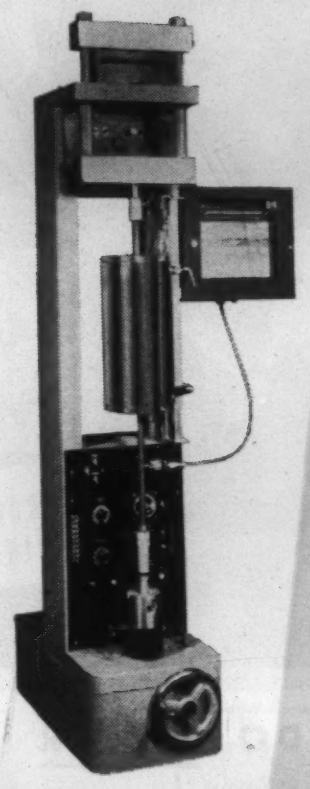
The authors report that polymethyl alpha-chloroacrylate can be stretched at least 150%, whereas Plexiglas 55 cannot be stretched more than 85%. All the materials recover gradually after stretching if heated to a sufficiently high temperature. The higher the heat distortion point of the unstretched material, the lower will be the extent of recovery at any given temperature. Also, the greater the

3 NEW MACHINES

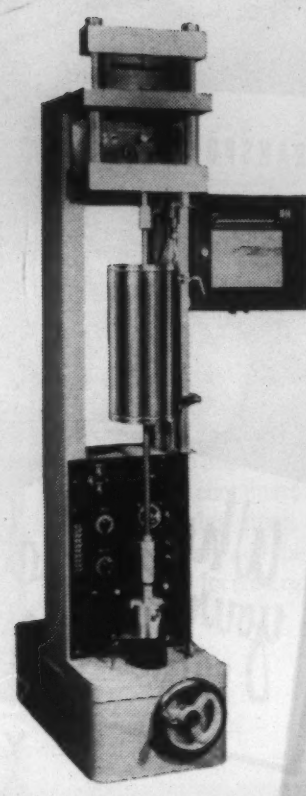
for better creep testing



LEVER TYPE FOR LONG-TIME CREEP TESTS. Model CL-20 (20,000 lbs. capacity). Load applied by dead weights. Lever ratio of 40 to 1 means less lifting for operator. Automatic take-up keeps lever arm horizontal as specimen elongates. Specimen fracture produces minimum shock since weights are maintained a fraction of an inch above base. Accuracy within ½% of load or 0.1% of capacity.



SPRING BLOCK TYPE FOR SHORT TIME CREEP RUPTURE TESTS. (Model CR). Available in 5 capacities, from 1,000 to 20,000 lbs. Load applied through dynamometer by motor-driven screw jack.



SPRING BLOCK TYPE MACHINE FOR AUTOMATIC CREEP RELAXATION TESTS. Model CX-04 (4,000 lbs. capacity).

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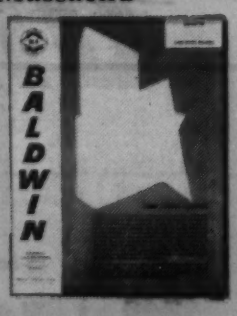

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degree of stretching, the greater is the extent of recovery at a given temperature. Most of the recovery occurs in the first two hours.

Effects of stretching

In general, multiaxial stretching causes the following effects on the plastics studied:

1. Decrease in resistance to surface abrasion.
2. Slight increase in tensile strength.
3. Large increase in strain at failure.
4. Little effect on the tensile modulus of elasticity.
5. Large increases in resistance to stress crazing and stress solvent crazing, the resistance to crazing increasing as degree of stretching increases.

The polymethyl alpha-chloroacrylate materials had the highest tensile strengths and showed the largest increases in tensile strength on stretching—probably because of the greater polarity of the molecule. Both before and after stretching tensile strength of Plexiglas 55 was slightly higher than that of Lucite HC-222. Strain at failure of the chloroacrylate materials was much less than that of the two methacrylate materials, both in the unstretched and the stretched state. None of the materials showed a large increase in modulus of elasticity on stretching, though the chloroacrylates showed the best improvement.

Crazing stresses raised

Crazing occurred at higher stresses in the chloroacrylate materials than in the methacrylate materials, but at a slightly lower percentage of the tensile strength

Foam Plastics Roundup

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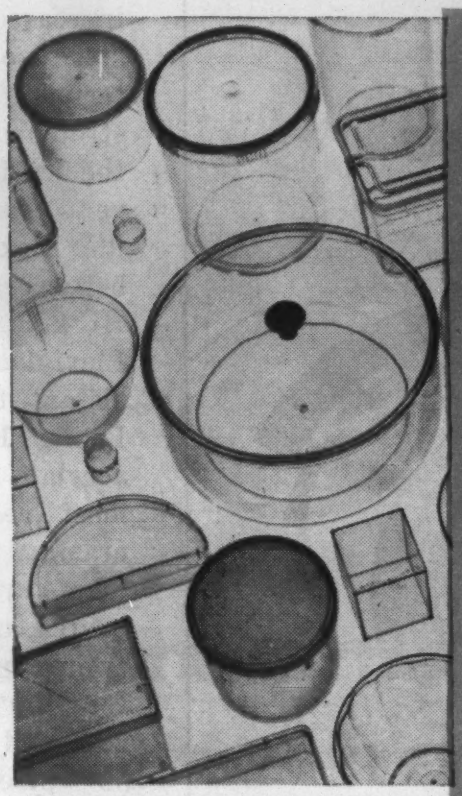
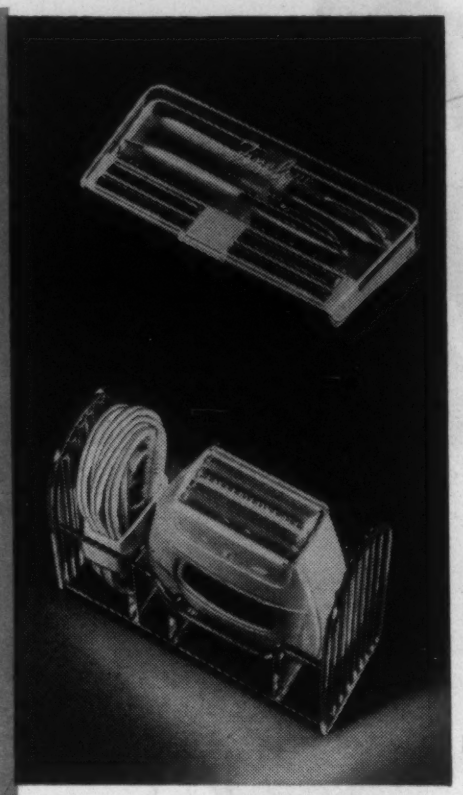
Below are typical applications of four Dylene formulations. If you would like more information about the family of Dylene polystyrenes, write to Koppers Company, Inc., Chemical Division, Dept. MM-56, Pittsburgh 19, Pennsylvania.

DYLENE 2

Outstanding flow properties of this plastic make it extremely useful in large-area, thin-section moldings. In high speed, fully automatic molding machines, Dylene 2 fills molds quickly at lower cylinder temperatures than are usually required for general purpose polystyrenes. It is used to make disposable packages, "egg crate" lighting panels, picnic spoons and tumblers.



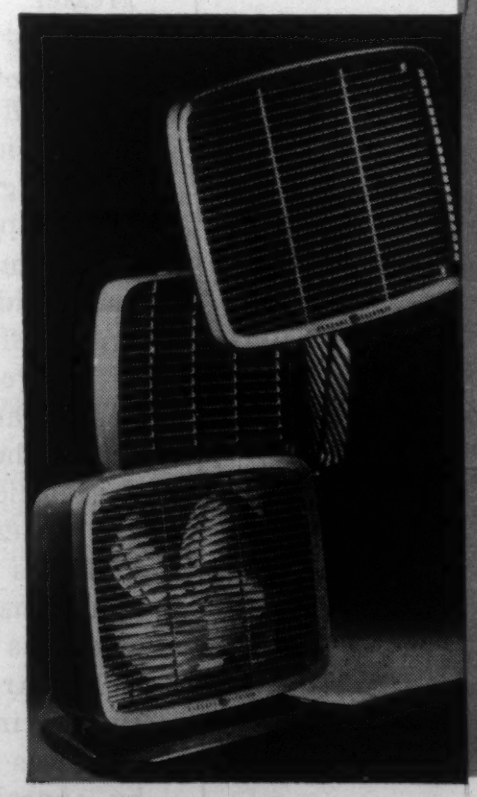


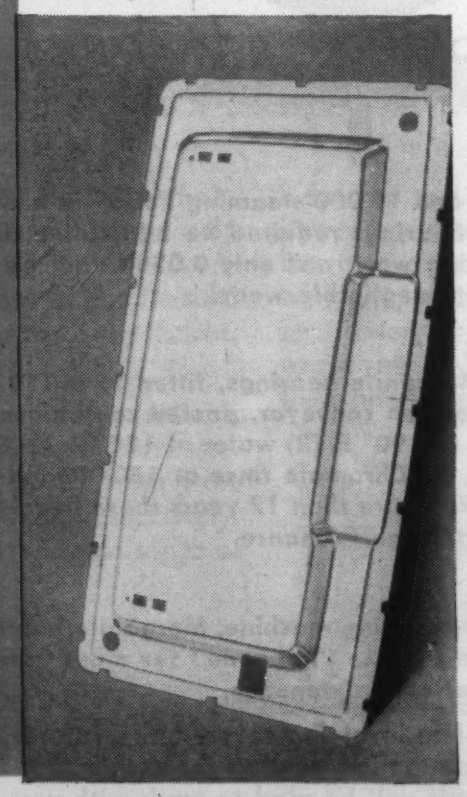
DYLENE 4

Easy flowing and fast setup characteristics make this plastic a real standout. Dylene 4 has greater strength and heat resistance than the usual easy flow polystyrenes. Result: faster cycling and ejection. This plastic is used to make combs, vials, thin-walled containers and display packaging items such as cases for pen and pencil sets and holders for electric shavers.

DYLENE 30

This medium impact polystyrene is not only easy to mold and fast to set up, but—it has a surface gloss and weld appearance that is almost indistinguishable from conventional polystyrenes. This unusual combination of properties makes this new plastic highly desirable for use in critical appliances such as air conditioner grilles, cosmetic caps and closures, housewares and toys.





DYLENE 200

Here is the easiest flowing polystyrene in the Dylene high impact line. Because of its easy molding properties, this plastic can be used in thinner sections than normal impact polystyrenes. It has excellent surface gloss and weld appearance. Dylene 200 is commonly used in refrigerator door liners, crisper trays, egg shelves, breaker strips and meat compartments, air conditioner grilles, housewares and toys.

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CONTENTS NOTED

and at a lower strain. Plexiglas 55 crazed at slightly higher stresses than Lucite HC-222. In general, however, specimens of stretched materials did not craze in standard tensile tests.

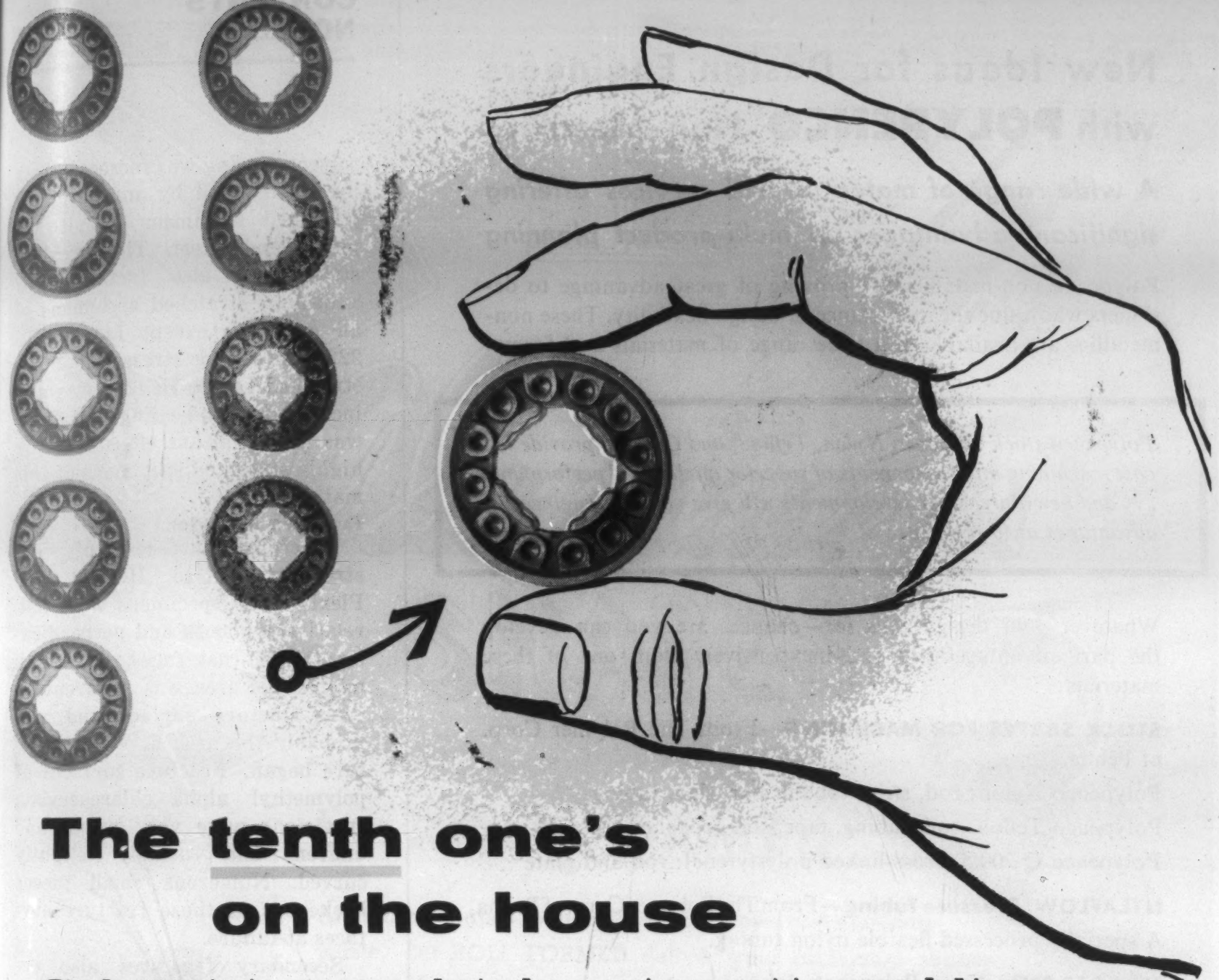
Multiaxial stretching markedly increased the threshold stress for stress-solvent crazing for all materials tested. Lucite HC-222, both stretched and unstretched, showed the least resistance to stress solvent crazing in ethylene dichloride. Plexiglas 55 had considerably better craze resistance than Lucite HC-222. In fact, 45%-stretched Plexiglas 55 was more craze resistant than the 150%-stretched Lucite HC-222. But the chloroacrylate materials were by far the most resistant to stress-solvent crazing with ethylene dichloride. The threshold stress for these heated, unstretched materials was approximately the same as that for 150%-stretched Lucite HC-222, and the threshold stress for 50%-stretched chloroacrylates was greater than that for 85%-stretched Plexiglas 55.

Effects of heating

The effects of applying heating and rapid cooling cycles and of annealing the test specimens were not completely consistent for all of the materials tested. Heating and rapid cooling did not significantly affect the tensile strength of any of the materials in the unstretched condition. Annealing unstretched specimens increased the tensile strength of both heated and unheated Lucite HC-222 and Plexiglas 55. Annealing stretched specimens increased tensile strengths in every case.

The stress at which crazing occurred in the standard tensile tests was not significantly affected by annealing or by the heating cycle except in the case of Plexiglas 55. For this material, both heating and annealing increased the crazing stress, but there was no difference between annealed specimens and specimens both heated and annealed.

The threshold stress for stress-



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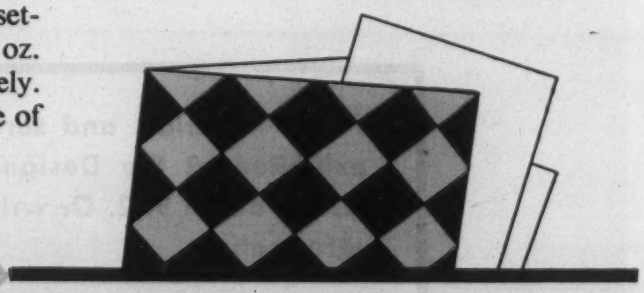

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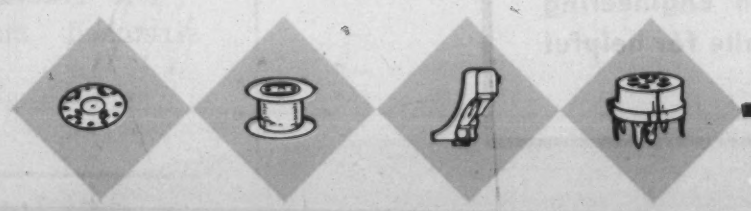

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solvent crazing was increased both by heating and by annealing unstretched specimens of all materials under test. The threshold stress was also increased by annealing stretched specimens of all materials except Lucite HC-222. Threshold stress for 50%-stretched Lucite HC-222 was also increased by annealing, but there was no significant effect on more highly stretched specimens of this material.

Fracture behavior

Fracture surfaces of unstretched Lucite HC-222 and Plexiglas 55 specimens were flat, relatively smooth and perpendicular to the cast faces. A smooth mirror-like area was apparent on each fracture surface and was probably the area at which fracture began. Fracture surfaces of polymethyl alpha-chloroacrylate specimens were very rough and uneven and usually slightly curved. Numerous small pieces broke out of these fracture surfaces at failure.

Secondary fractures also occurred in many chloroacrylate tensile specimens. Most of these fractures occurred in the portion of the specimen held by the tensile grips and were probably related to the stresses caused by the grips; however, in some cases multiple fractures occurred in the reduced portion of the chloroacrylate tensile specimens. A few Plexiglas 55 specimens had secondary fractures in the tensile grip region, but there were none in the Lucite HC-222 specimens.

The fracture surfaces of the stretched materials showed a

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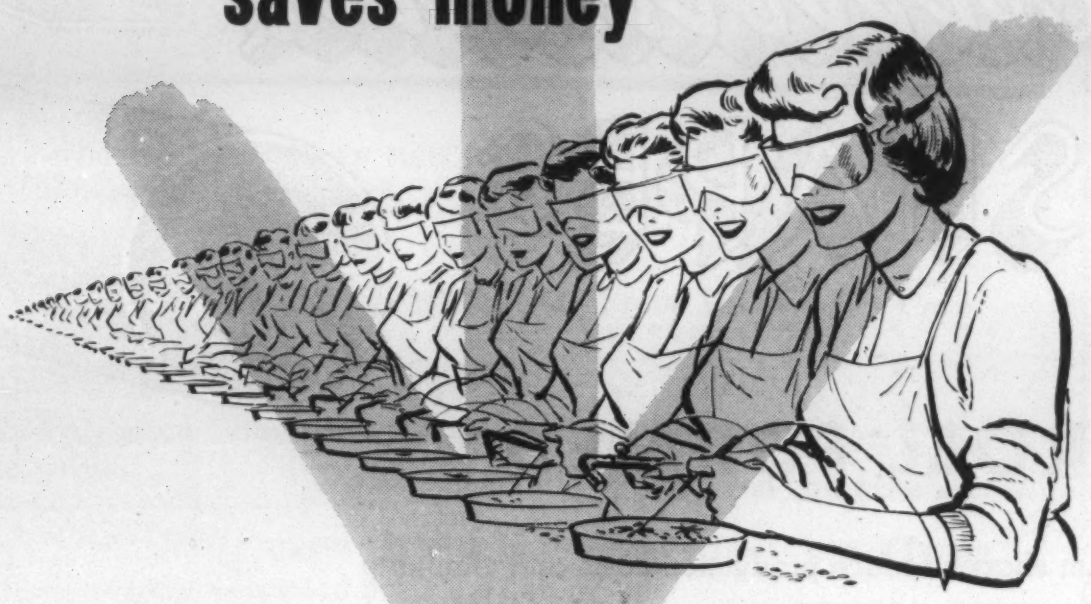

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laminar structure that had been observed in previous investigations. This structure probably results from orientation of the molecule chains in layers parallel to the plane of the sheet. The higher the degree of stretching, the more apparent was this layer-like orientation. In many cases, a triangular-shaped piece split out of a tensile specimen of stretched material at the point of failure.

Conductive Coatings Applied to Glass

Because of their electrical conductivity, transparent metal oxide coatings are particularly well suited for use as resistance elements to prevent mist and ice formation on the windows of aircraft, control towers and other equipment. Early attempts to manufacture "conductive glass" by the addition of bulk conducting materials, such as lead oxide, were unsuccessful because of reduced optical transmission. High conductivity and optical transparency can now be obtained by depositing an adherent layer of metal oxide directly on the surface of the glass.

In a paper appearing in the Dec. '55 issue of *Vacuum* (British), L. Holland and G. Sidall state that conducting metal oxide films have recently been deposited by 1) cathodic or reactive sputtering of a metal in a glow discharge containing oxygen, and 2) producing a reaction between a metal halide and water vapor.

Two types of films

Two distinct types of transparent films can be used as heating elements. The first is a semiconducting metal oxide layer, whose conductivity depends not only on the thickness and the physical state of the film, but also upon its state of oxidation and the number of impurity centers in the crystal structure. With

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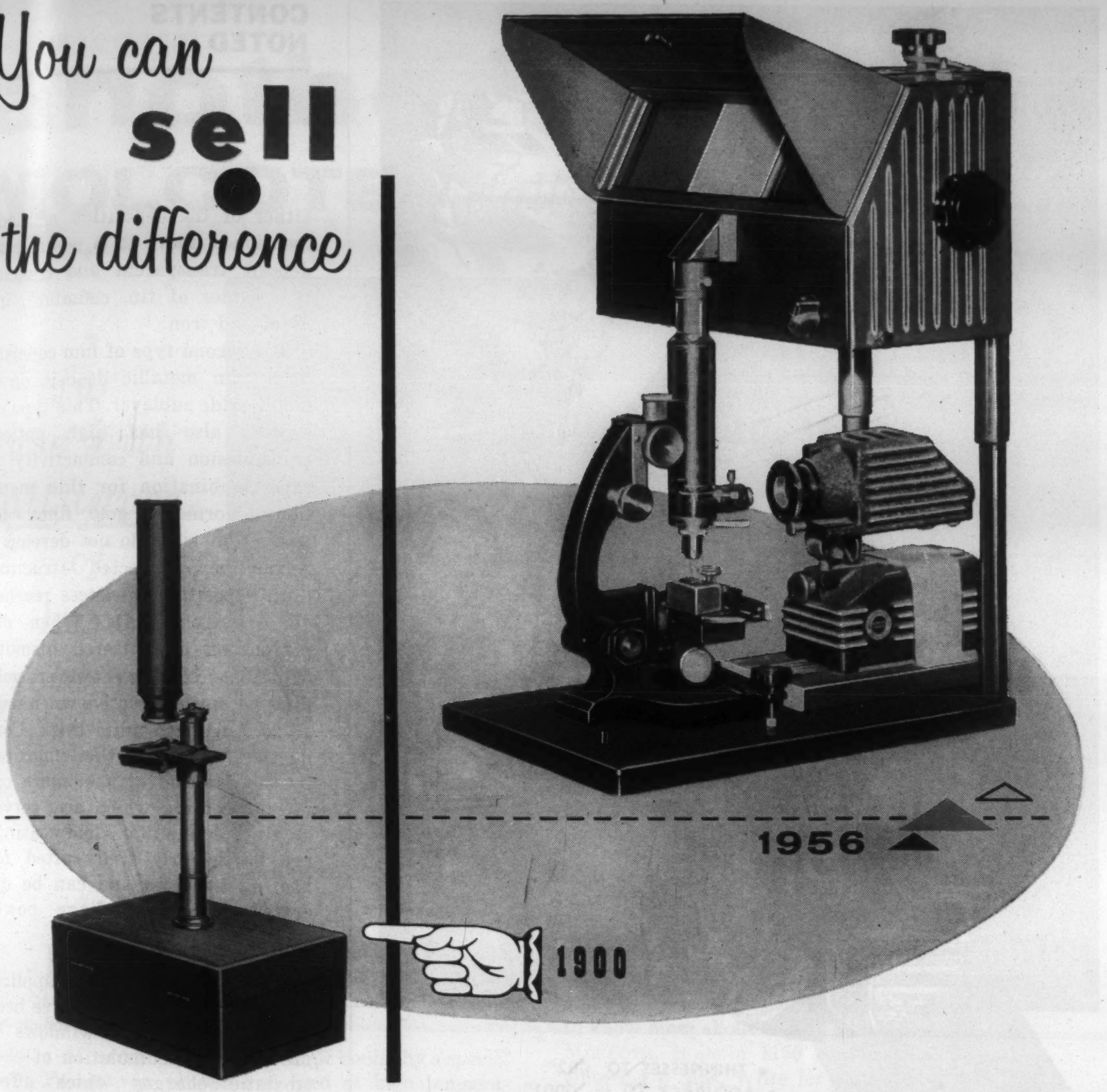

The pocket-size "personal" microcsope shown at the left was one of the first metals research and quality control instruments in daily use at Scovill more than half a century ago.

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CONTENTS NOTED

either of the deposition methods mentioned above it is possible to deposit transparent and conductive oxides of tin, cadmium, indium and iron.

The second type of film consists of a thin metallic deposit on a metal oxide sublayer. This type of deposit also has high optical transmission and conductivity, a rare combination for thin metal films. Normally, gold films deposited on glass do not develop a conductive, connected structure until deposition thickness reaches 40 Angstrom units. When deposited on a sputtered bismuth oxide base coating, however, gold films become conductive when only 15-20 Angstrom units thick. Conductivity can be further improved by the addition of a bismuth oxide top coating which also serves as a protective film. Gold coatings are particularly well suited for heating windows and can be operated from low-voltage power supplies.

Applications

In addition to aircraft applications, metal oxide films have been used on instrument windows to prevent the accumulation of electrostatic charges which affect meter readings. Since resistivity of some films is stable up to 750 F, these coatings may also prove useful as high power resistors.

Because of their high refractive index and low optical absorption, bismuth oxide films have been used as beam splitters in optical interferometry. Iron oxide films have been used for a similar purpose in the infra-red region.

Deposition of metal oxides on clear plastics has not been successful. Reactive sputtering of cadmium oxide on acrylics has been attempted, but the material rapidly outgasses when exposed to a glow discharge and the surface becomes discolored due to the decomposition of the plastic under ion bombardment.

(Books on p 256)

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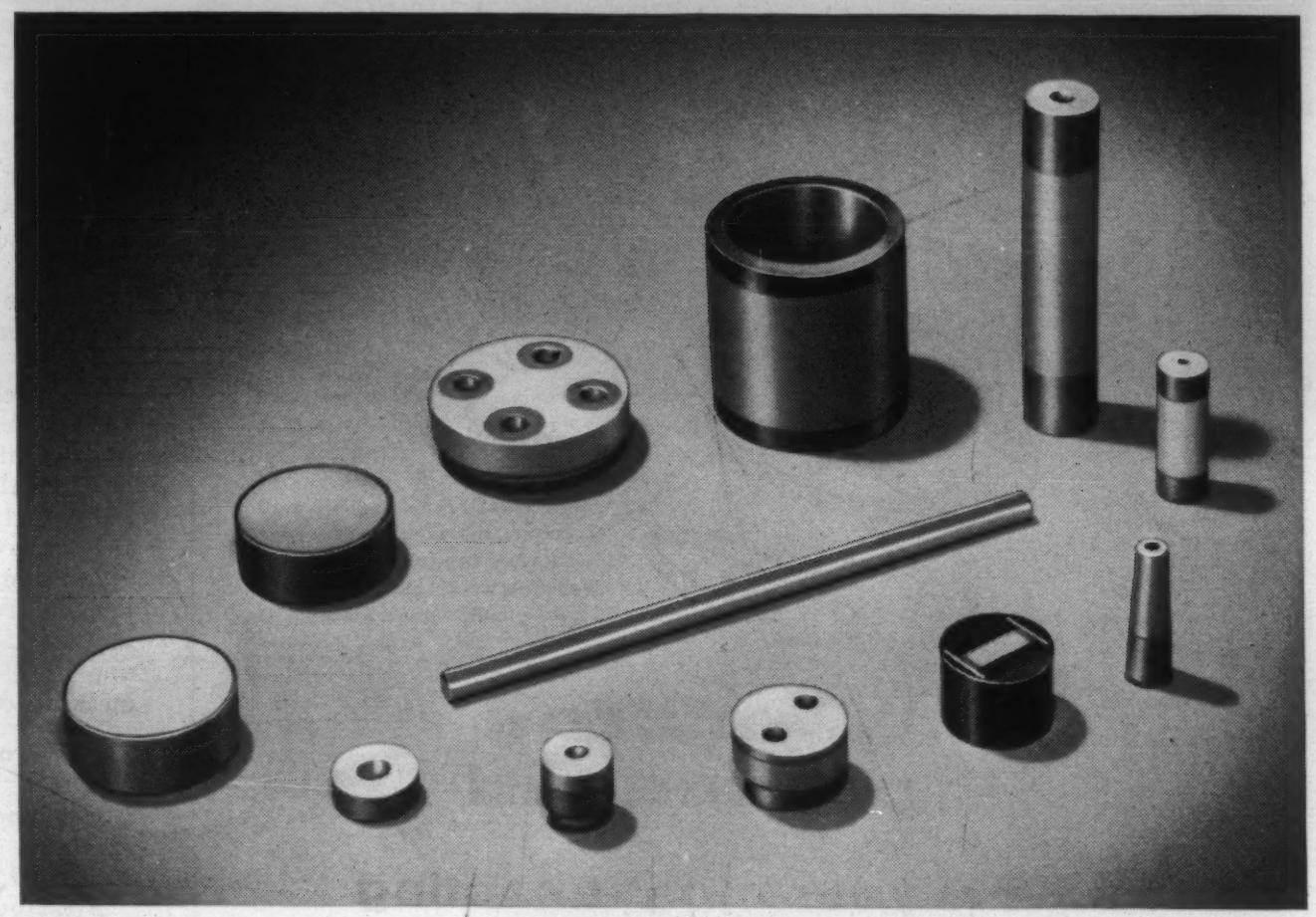

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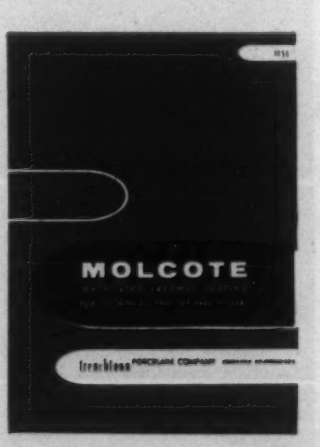

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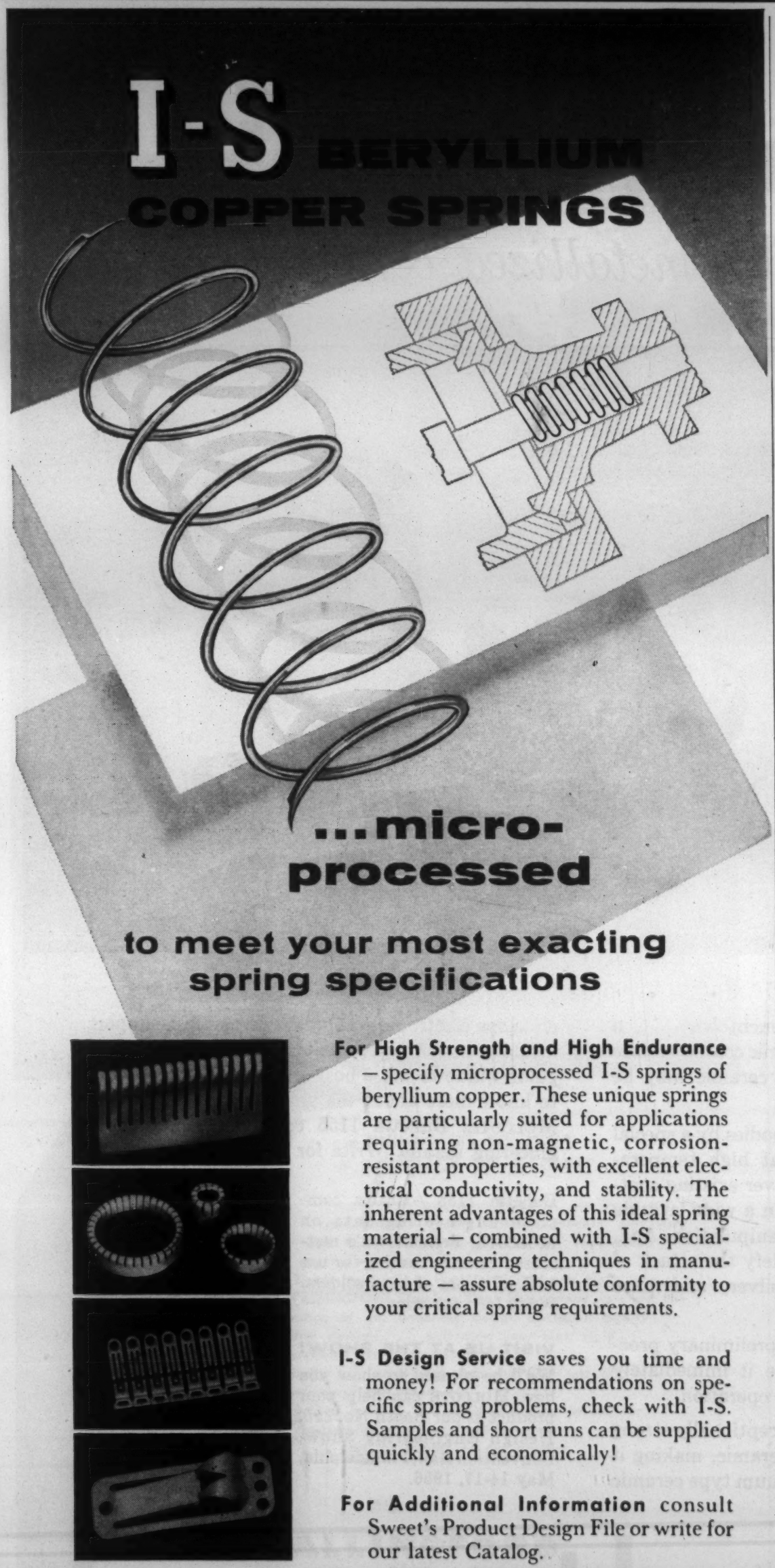

CONTENTS NOTED

BOOKS

Aluminium in Contact with Other Materials. *The Aluminium Development Assn., London, W. 1, England. 1955. Information Bulletin No. 21. Paper, 5¼ by 8½ in. 46 pp. Price $0.50.*

Appropriate measures for the most effective use of aluminum in contact with other materials are described. Brief notes on the causes and types of corrosive attack, essential to subsequent explanation, are followed by a discussion of the principles of preventing attack and, at greater length, by accounts of the behavior of aluminum in contact with specific materials.

Two important tables show 1) an approximate grouping of aluminum and its alloys for exposure in rural, industrial and marine areas, and 2) the behavior of couples involving aluminum when exposed to particular environments such as marine, industrial or total immersion. An appendix summarizes the nature of metallic corrosion.

The Properties of Aluminium and Its Alloys. *The Aluminium Development Assn., London, W. 1, England. 1955. Paper, 5½ by 8½ in. 204 pp. Price $1.25.*

First published in 1942, this bulletin was revised in 1944 and 1948. The present edition covers the 1955 revision of British standards for aluminum and aluminum alloys for general engineering purposes. It also incorporates data for alloys as specified for aircraft use and the proprietary names under which many compositions are supplied, including separate lists indicating the compositions of alloys other than British.

Materials Handbook, Eighth Edition. *George S. Brady. McGraw-Hill Book Co., New York 36, N. Y. 1956. Cloth, 6 by 9 in., 1018 pp. Price $11.00.*

This edition of the encyclopedia covers approximately 10,000 materials. It concentrates on supplying the most essential and useful information on characteristics, sources, substitutes and properties of metals, alloys, abrasives, refractories, woods, industrial and plating chemicals and others. Included also is a section on economics.

The book will be particularly useful as a reference for purchasing agents, engineers and executives who are seeking a brief summary of the characteristics of a material.

Powder Metallurgy—Now (New Techniques, Improved Properties, Wider Use). *F. V. Lenel. American Society for Testing Materials, Phil-*

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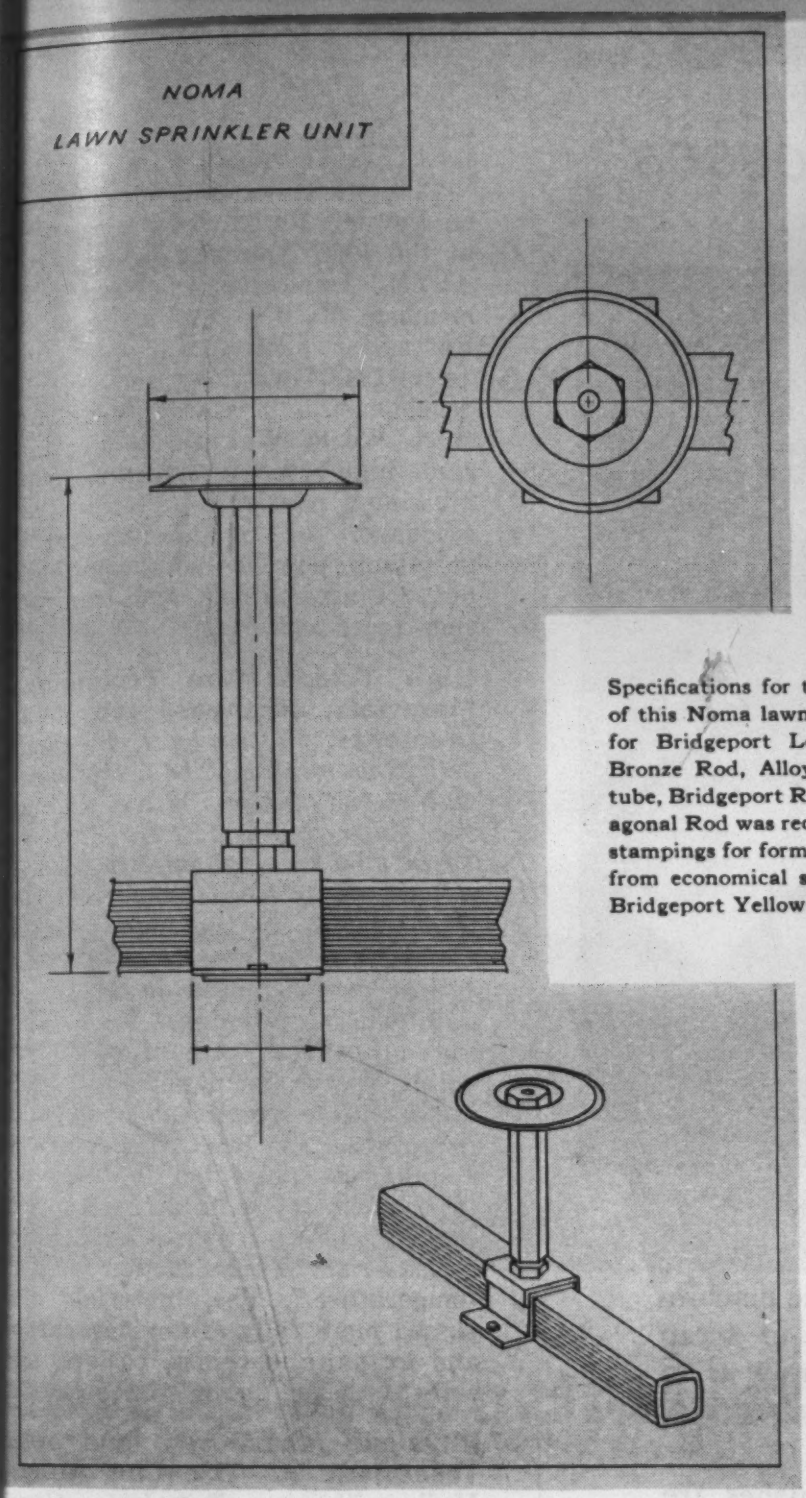
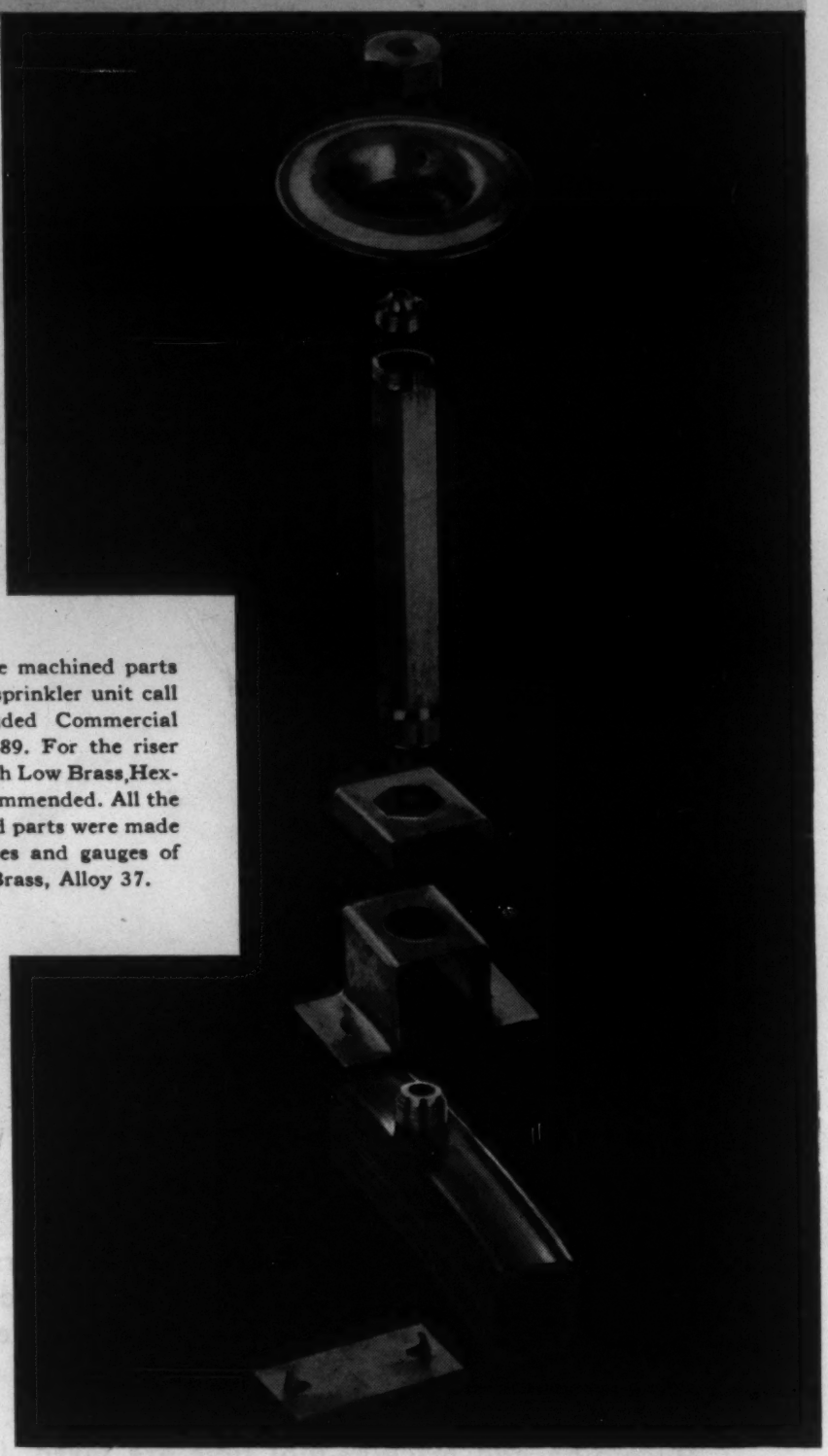


Specifications for the machined parts of this Noma lawn sprinkler unit call for Bridgeport Leaded Commercial Bronze Rod, Alloy 89. For the riser tube, Bridgeport Rich Low Brass, Hexagonal Rod was recommended. All the stampings for formed parts were made from economical sizes and gauges of Bridgeport Yellow Brass, Alloy 37.



Photos courtesy Noma Spray Division, Noma Lites, Inc.

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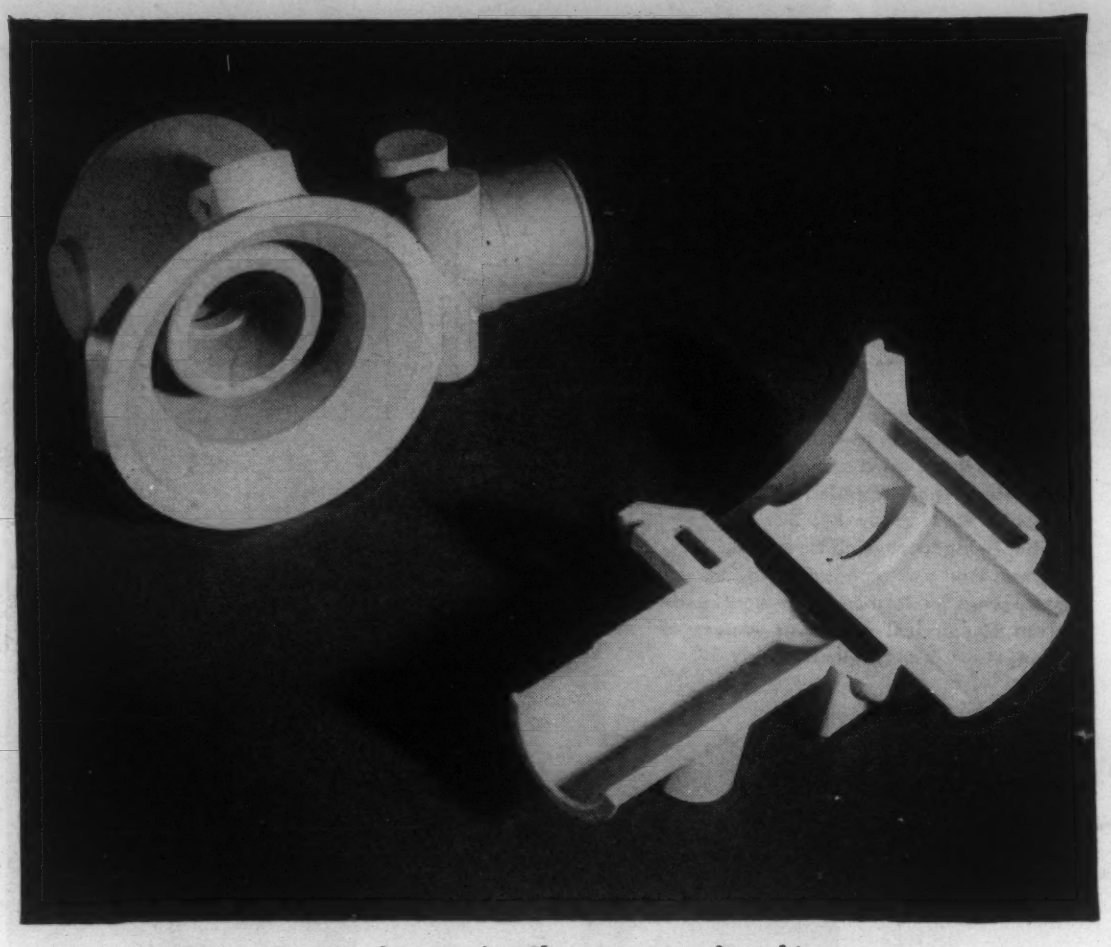

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As a sand casting, this part required twelve separate machining operations, with their inherent hazards of scrap losses, tool breakage and production delays. Made now as an investment casting by Precision Metalsmiths, only six machining operations are required.

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BOOKS

adelphia, Pa. 1955. Paper, 6 by 9 in. 34 pp. Price $1.50.

This 4th Gillett Memorial Lecture on Powder Metallurgy was presented at the 1955 Annual Meeting of the ASTM. Dr. Lenel, who has been a member of the teaching staff of Rensselaer Polytechnic Institute since 1947, evaluates some of the developments in powder metallurgy since World War II. Subjects include high strength structural parts, aluminum powder metallurgy, pelleting, extrusion of magnesium alloys, beryllium powder metallurgy, powder rolling, cermets and transpiration-cooled materials.

High Temperature Technology. Materials, Methods, and Measurements. *Edited by I. E. Campbell. Sponsored by The Electrochemical Society. John Wiley & Sons, Inc., New York 16, N. Y. 1956. Cloth, 6 by 9 in., 526 pp. Price $15.00.*

This is a concise account of recent developments in the high temperature field by 35 research workers. It covers methods used in production and explains techniques for measuring properties. According to the editor, it was not possible to include an extensive treatment of metallic materials. "A brief discussion of metallics is presented to point out their potential usefulness in special applications and their shortcomings as materials of construction for high temperature." The materials discussed more fully are oxides, carbon and graphite, carbides, borides, silicides, nitrides, sulfides and cermets.

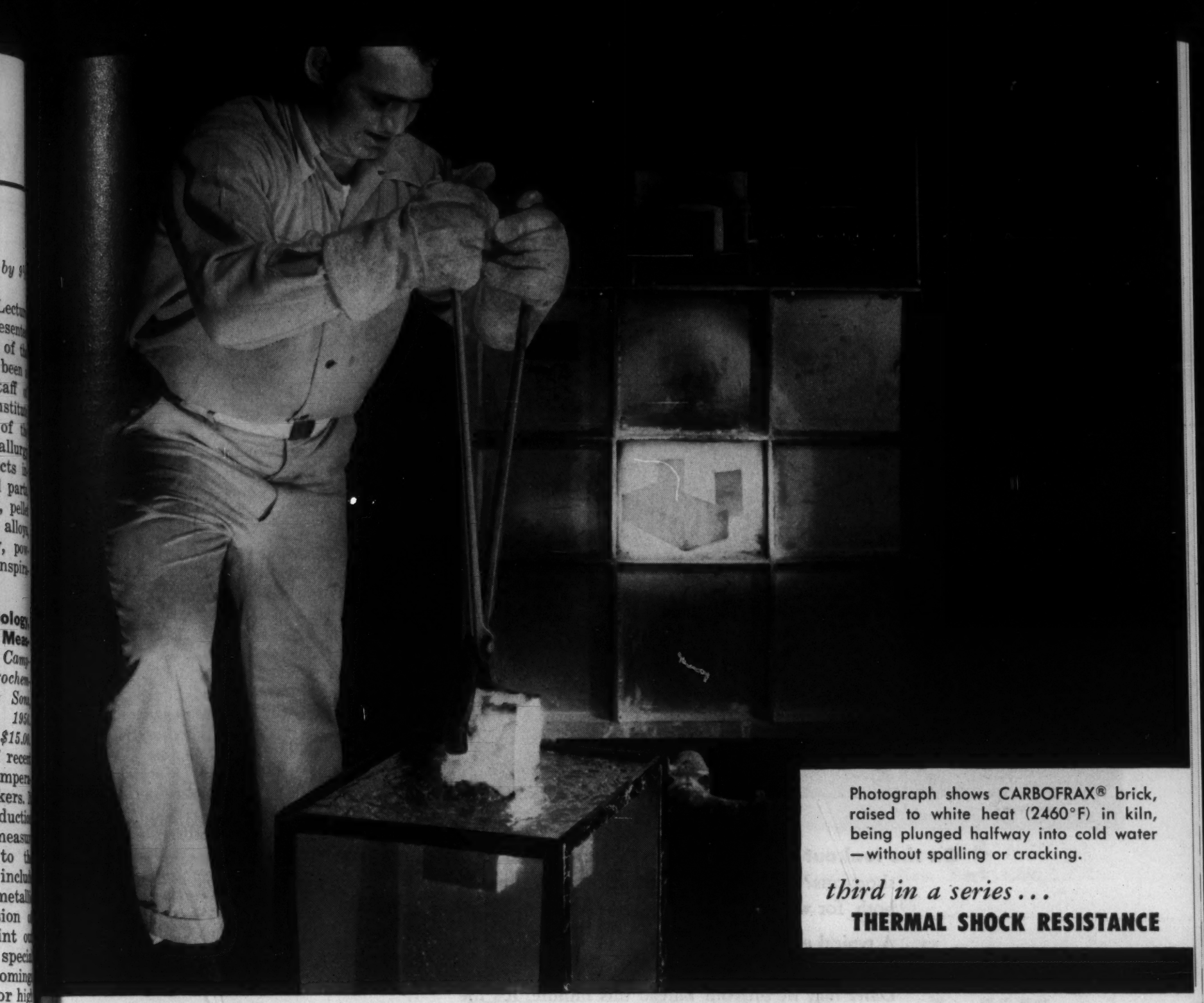
Physical Metallurgy and Heat Treatment of Titanium Alloys. *Mallory-Sharon Titanium Corp., Niles, Ohio. 1955. Cloth, 6 by 9 in. 59 pp. Price $1.00.*

The purpose of this report is to define and clarify titanium alloy heat treatment for the benefit of both producers and fabricators. It covers three major subjects: "Theory of Hardening," "Annealing" and "Hardening." The latter two major

Progress in Plastics

Coming in June

A staff review of the major developments that have occurred since the last National Plastics Exposition two years ago. It will not only cover new materials and fabricating techniques, but will also point up the emergence of more complete engineering data on plastics.



Photograph shows CARBOFRAX® brick, raised to white heat (2460°F) in kiln, being plunged halfway into cold water —without spalling or cracking.

third in a series . . .

THERMAL SHOCK RESISTANCE

Unusual Properties of Refractory Materials

hermal Shock Resistance in a refractory enables it to ithstand rapid recurring temperature changes without alling and cracking. Several properties affecting the degree resistance include: thermal conductivity, ultimate ength, thermal expansion and modulus of elasticity.

A number of refractories developed by Carborundum are oted for having these properties in the ranges that insure gh heat shock resistance. They successfully meet the esses and strains imposed by intermittent firing and by gh heat releases in restricted areas. In packaged steam nerator service, for example, they are far superior to other ning materials. Similarly, they have produced outstanding sults in rapidly-heated quickly-cooled crucible type melt- furnaces, in heat treating furnaces, incinerators, still ttings, etc.

The current issue of Carborundum's magazine "Refrac- ies" features a comprehensive article on heat shock. It ay offer suggestions helpful to you in handling a condition f this nature. Send for your copy today.

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· PLASTICS IN ACTION

On the lookout for assembly savings? Production short-cuts? Improved appearance or service life, or both, for what you make and sell?

A typical example of how thousands of companies have solved problems like this by *designing with Durez* may be on your bureau this minute. It's the motor bearing support in the new Schick "25".

With weight, close dimensional control, and impact strength at a premium, the right Durez phenolic yields advantages on all three counts. Notice the number of complex inserts—a Durez design factor that is shaving costs in many a product.

What else must you have in a material . . . resistance to heat, moisture, acids, mild alkalies—self-insulation—lustrous molded-in finish? Here you have them all, in combinations to fit your job.

Look into these engineering plastics now. Talk with your molder—and feel free to make use of our technical help.

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DUREZ PLASTICS DIVISION

HOOKER ELECTROCHEMICAL COMPANY

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CONTENTS NOTED

BOOKS

subjects are subdivided into three alloy types: alpha, martensitic and metastable beta alloys. The data are based on an investigation carried out under a Navy contract at the Mallory-Sharon Research Laboratory. Included are 32 illustrations, an index and a reference section.

Nuclear Metallurgy, A Symposium on Behavior of Materials in Reactor Environment. *The American Institute of Mining and Metallurgical Engineers, New York 18, N. Y. 1955. Paper, 8½ by 11 in. 94 pp. Price $3.75.*

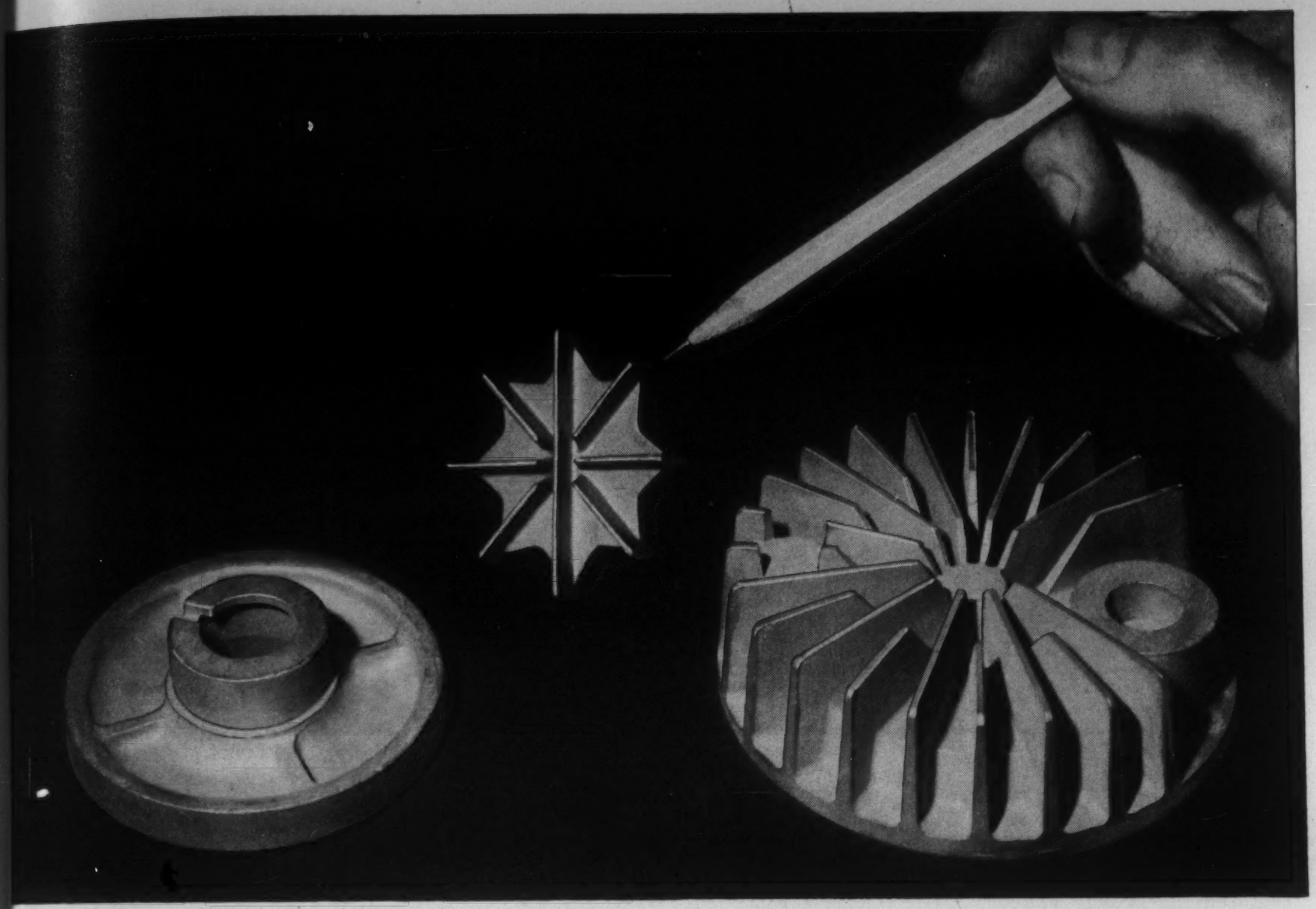
This book contains six technical papers presented at the Annual Meeting of the AIME in New York in February 1956. The papers are: "General Problems in the Application of Materials in Reactor Environments," "The Behavior of Materials in Aggressive Liquid Metals," "Behavior of Materials in Non-aggressive Liquid Metals," "The Application of Materials in Low Temperature Water and Organic Liquid Cooled Reactors," "Structural Materials for Use in the Pressurized Water Power Reactor" and "Corrosion of Materials in Fused Hydroxides."

REPORTS

Seal materials Wear of Typical Carbon-Base Sliding Seal Materials at Temperatures to 700 F. *Robert L. Johnson, Max A. Swikert and John M. Bailey. Feb 1956. 22 pp, diags, photos, tables. Available from National Advisory Committee for Aeronautics, 1512 "H" St. N.W., Wash. 25, D.C. (NACA TN 3595)*

Wear and friction studies were made with carbon-type seal materials sliding against tool steel, stainless steel and chromium-plated steel at temperatures to 700 F and a sliding velocity of 10,000 fpm. Wear was several times greater at 500 F and above than with no heat added for all carbon materials. The mating material had more effect on wear and surface failure than did the use of various impregnants in the carbon. Chromium plate gave less wear than the other mating materials under all conditions of the experiment.

Creep in reinforced plastics Influence of Temperature on Creep, Stress-Rupture, and Static Properties of Melamine-Resin and Silicone-Resin Glass-Fabric Laminates. *William N. Findley, Harlan W. Peithman and Will J. Worley, Univ.*



Spins in salt water—Pencil points to "PITLOG" impeller that spins in salt water at 6000 RPM. All three parts are Monel precision castings made by Inco for Pitometer Log Corporation, New York City.

With Inco Precision Casting, precision-balanced *impeller*

needs no milling, little hand filing

These parts go into a "sea speedometer." It's a Pitometer Log that translates water velocity under a ship into knots. And when you remember how corrosive fast-moving salt water is, you know why the parts are made of Monel* nickel-copper alloy.

For the Monel castings, the people who make "PITLOGS" called on Inco's "know-how" with nickel alloys.

Inco *precision* casting cut machining time 30%

That's a round figure for all three parts. The time-saving is nearer 50% in machining the intricate ribbed cover you see at right. Inco precision casting also enabled "PITLOG" engineers to redesign this part. Reduce its wall thickness. Improve its geometry. Minimize scrap.

Previously, when the center impeller was sand cast, "PITLOG" machinists had to mill the ribs. And they had to hand file the webs between the ribs to balance the impeller. *Inco precision casting eliminated all milling.* It reduced the hand filing appreciably, too.

Where can you save with Inco precision casting?

Do you have a part which is 6 inches by 5 inches or smaller? Does it weigh under 3 pounds? Require starting tolerances as close as plus or minus .005 inch per linear inch? And need 5 or more fabrication steps? If so, there's a good chance you can cut cost and improve design by having the part precision investment cast by Inco.

Inco precision casts most high-melting point alloys from carbon steel to the new super alloys.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

5 Advantages of INCO Precision Casting

- Save up to 60% of production costs.
- Longer life with harder alloys.
- Little or no machining required.
- Wider design latitude.
- Higher alloys at lower cost.

Get This Helpful New Booklet

Trying to keep costs in line on some small part? Then write for new 16-page booklet, "Cast to Outlast." Contains many case histories detailing how others cut costs with Inco precision castings. There is a good chance this helpful data will suggest a practical way to cut your costs, too.

Inco Castings

INCO TRADE MARK

Precision • Sand • Centrifugal

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Important! Specify TEFLON® by its properties!

TEFLON *can* provide extraordinary physical, electrical, and chemical properties, but these properties *cannot* be taken for granted.

The method used to convert Teflon powder into finished rods, sheets, and tubes greatly affects the quality obtained. This quality, in turn, governs the properties of the end product.

So to *assure* performance, actually specify not only Teflon but also the important *properties* required.

Two grades of Fluoroflex®-T deliver the *optimum* properties you specify for Teflon.

(1) "Electrical grade" Fluoroflex-T is certified to conform to all important electrical and physical properties. It meets the most critical requirements.

(2) A more economical "mechanical grade" satisfies all chemical and thermal needs and offers up to 50% greater resistance to elongation under mechanical loads.

Both grades are produced under exacting quality control standards and are stress relieved to insure that machined parts are dimensionally stable.

Send for data or better still tell us what specific properties are important for your application.

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Warehousing Distributors: Western Fibrous Glass Products, Los Angeles, Calif.; F. B. Wright Co., Detroit, Mich.; Colonial Kolonite Co., Chicago, Ill.; Industrial Safety Supply Co., Hartford, Conn.; Lone Star Rubber Co., Houston, Tex.; Flow Products, Inc., Chicago, Ill.

For more information, turn to Reader Service Card, Circle No. 620

CONTENTS NOTED

REPORTS

of Illinois. Jan 1956. 71 pp, diags, photos, tables. Available from National Advisory Committee for Aeronautics, 1512 "H" St. N.W., Wash. 25, D.C. (NACA TN 3414)

Results of static-tension, static-compression, tension-creep and time-to-fracture tests of melamine-resin and silicone-resin glass-fabric laminates at temperatures up to 400 and 600 F, respectively. Creep data supply additional evidence that the percent increase in strain from one given time to another given time is independent of stress. Effect of stress, time and temperature are summarized by an equation based on the activation-energy theory and a power function of time.

Porous materials On the Permeability of Porous Materials. *E. Carson Yates, Jr. Jan 1956. 31 pp, diags. Available from National Advisory Committee for Aeronautics, 1512 "H" St. N.W., Wash. 25, D.C. (NACA TN 3596)*

Experiments showed permeability of porous materials to be appreciably affected by the absolute pressure level, choking of the flow and material thickness. Moderate bending of the material caused no noticeable change in the permeability. Simple calculation and correlation procedures were developed for determining permeability with reasonable accuracy when experimental data are limited. The work was done with rolled Monel metal cloth and sintered bronze.

Alumina cutting tools Literature Survey on Aluminum Oxide Base Cutting Tools. *F. S. DeLacey, Watertown Arsenal. Aug 1954. 20 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. 50 cents. (PB 111759)*

Declassified AEC reports

Photocopies of the following reports may be obtained from Atomic Industrial Forum, Inc., 260 Madison Ave., New York 16; Georgia Inst. of Technology Library, Atlanta; John Crerar Library, 86 E. Randolph St., Chicago 1; or Stanford Research Inst., Stanford, Calif. An asterisk (*) following the number of pages indicates that a full size printed copy of the report may be purchased from Office of Technical Services, Dept. of Commerce, Wash. 25, D.C.

Hot water corrosion Corrosion of Metals in High Temperature Water at 500 and 600 F. *S. C. Datsko and*

For more information, Circle No. 541

Towers designed and fabricated by American Bridge Division of United States Steel for Florida Power Corporation. Erected by Southeastern Utilities Service Company, Miami, Fla.

26 tons of weight saved by USS MAN-TEN Steel saves $7,200 in erection costs

Because power transmission towers are frequently installed in locations far removed from regular means of transportation, every pound saved reduces shipment and erection costs.

The four towers crossing Old Tampa Bay from the Florida Power Corporation's Higgins plant forcibly illustrate this fact. These towers, built 198 ft. high to provide a 100 ft. clearance over mean low water, had to be designed to resist hurricane force winds of 135 mph, with an overload capacity factor of 1.25.

The high strength required was readily obtained by using USS MAN-TEN Steel rather than plain carbon steel in the tower legs. At the same time, because of MAN-TEN's high yield point of 50,000 psi, it was possible to reduce weight of legs by 26 tons. This considerable saving in steel tonnage reduced the cost of the towers even though USS MAN-TEN Steel costs a little more.

The big saving, however, was in cost of erection.

There were two different rates involved; one for erection over water and one for erection on land. 6½ tons were trimmed from each of the three towers erected over water, resulting in a $6,000 saving. The tower erected on land weighed 6 tons less, providing an additional $1,200 saving—or a total erection cost saving of $7,200.

If you are looking for construction that will save money for you by reducing weight, prolonging life and minimizing maintenance—at little or no increase in first cost—find out more about USS High Strength Steels—USS MAN-TEN, USS COR-TEN and USS TRI-TEN. You'll find our 174-page "Design Manual for High Strength Steels" extremely useful in applying these steels. For free copy write—on your company letterhead—to United States Steel Corp., Room 5233, 525 William Penn Place, Pittsburgh 30, Pa.

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NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
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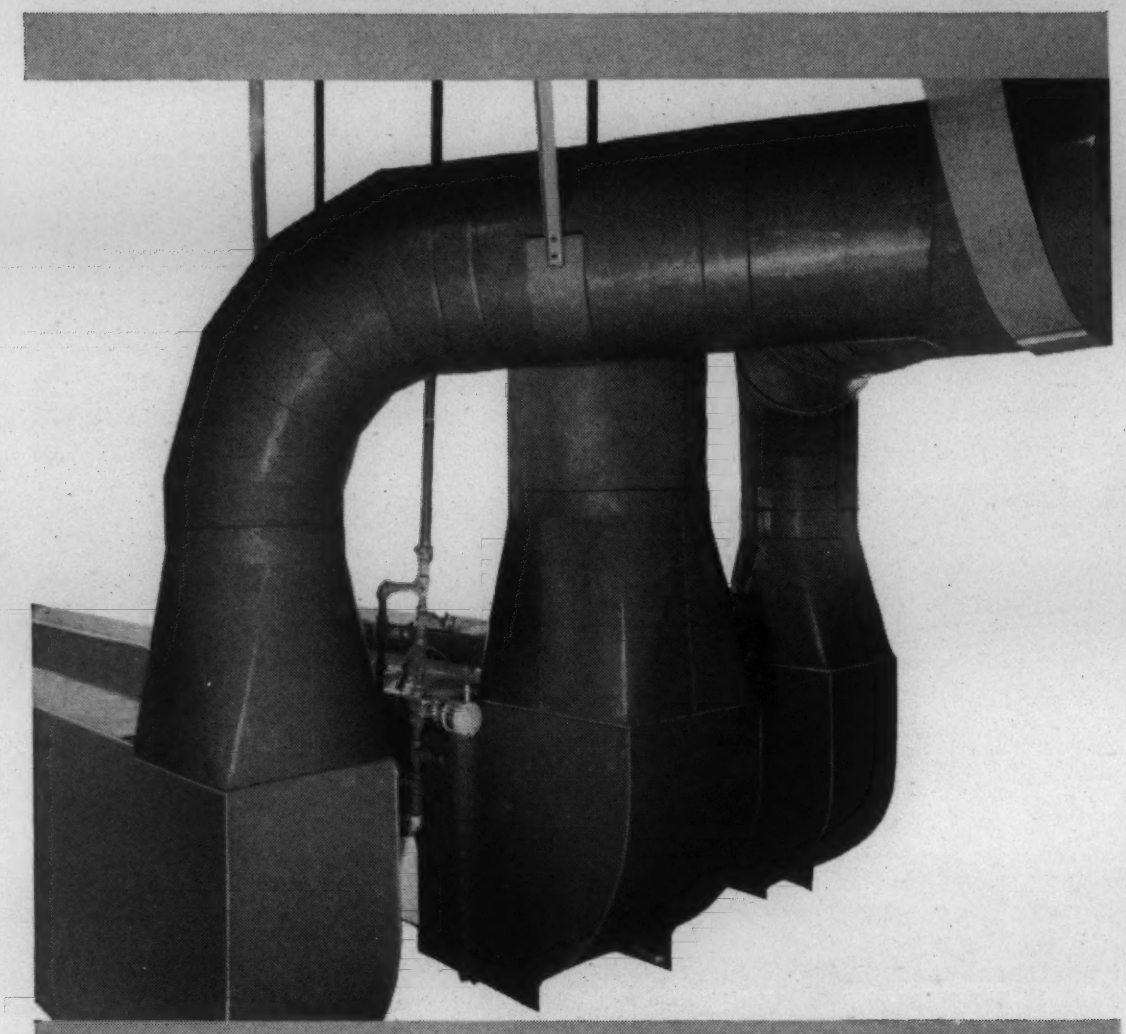
USS HIGH STRENGTH STEELS

USS MAN-TEN · USS COR-TEN · USS TRI-TEN

6-672

UNITED STATES STEEL

anodizing fume corrosion stopped



by KAYKOR VYFLEX® F-92 PVC

A large midwestern manufacturer of aluminum parts for household appliances was having corrosion troubles. All efforts to keep a fume exhaust system in service over the anodizing tanks failed . . . until he discovered F-92 structural PVC. In a typical application of this tough, resistant material, his 25′ anodizing tanks were equipped with F-92 hoods, which vented fumes to 24″ and 32″ stacks of the same material.

Sulfuric acid splash and fume from the anodizing tanks can't harm the new exhaust system because it's completely fabricated of unplasticized Polyvinyl Chloride . . . even to the nuts and bolts. Inert to the widest range of corrosive processing agents, at temperatures to 165F, this Kaykor material also offers such attractive physical properties as high tensile and flexural strength, hardness, abrasion resistance, and electrical and thermal insulation properties.

Well equipped, highly experienced Kaykor fabricators across the country stand ready to solve *your* corrosion problems with standard or custom designed equipment and parts of VYFLEX F-92 PVC.

GET THE FACTS! Write for complete information in new Bulletin "F-92", available free on request to Kaykor Industries, Inc., 4405 Broad St., Yardville, New Jersey, or ask your local Kaykor fabricator.

KAYKOR INDUSTRIES INC.
Division of Kaye-Tex Manufacturing Corp.
YARDVILLE, NEW JERSEY

For more information, turn to Reader Service Card, Circle No. 519

CONTENTS NOTED

REPORTS

*Calvin R. Breden. Argonne National Lab. and Babcock & Wilcox Co. Research Center. Oct 6, 1954. 203 pp.**

Corrosion behavior of a series of structural materials, including zirconium and zirconium alloys. Discusses effects of several water treatments not generally used which were employed in an attempt to minimize corrosion.

Conductivity of refractories The Measurement of Thermal Conductivity of Refractory Materials. *W. D. Kingery and F. H. Norton. Massachusetts Inst of Technology. Oct 1, 1955. 16 pp.**

A quarterly progress report giving thermal conductivity data for the magnesium oxide-silica and alumina-zirconia systems, and for polycrystalline titanium dioxide. Infrared absorption data in the temperature range from room to 2150 F are reported for fused silica and sapphire. An expression for radiant heat transfer in opaque powders is derived.

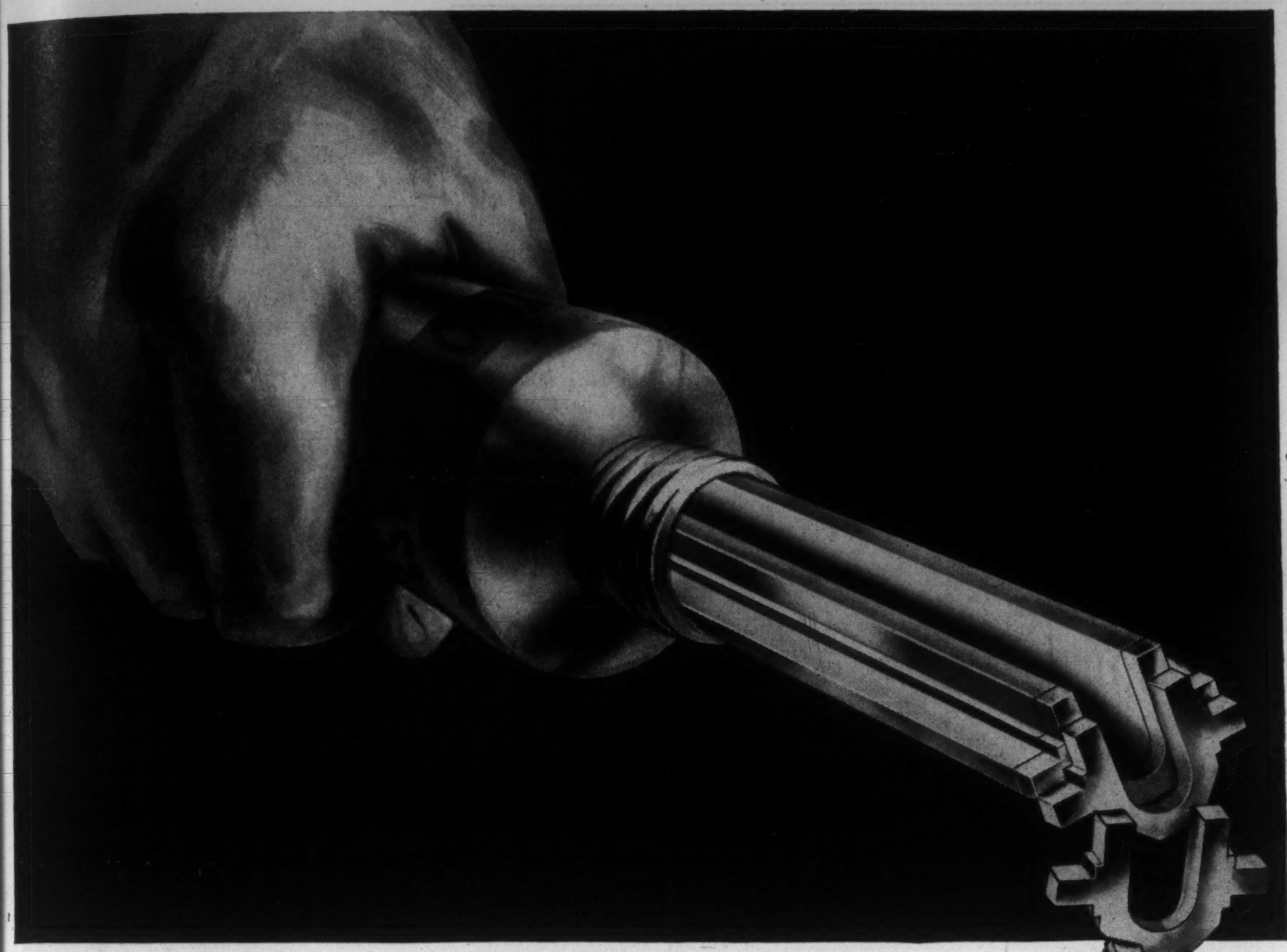
Zirconium cups The Development and Production of Heavy-Walled Back-Extruded Zircaloy-2 Cups. *J. G. Goodwin and R. W. Tombaugh. Westinghouse Electric Corp., Atomic Power Div. Oct 29, 1955. 46 pp.*

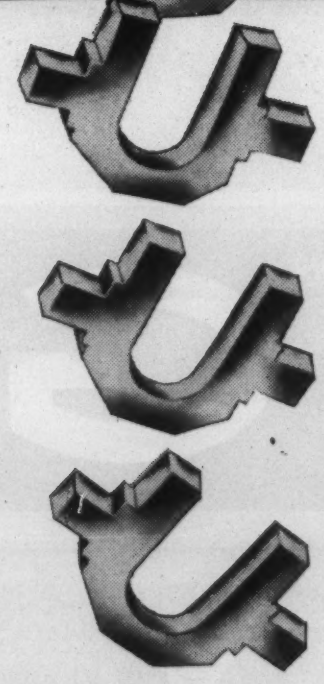
Discusses 1) bar stock preparation, 2) development work at Scaife Co., Aluminum Co. of America, Wyman-Gordon Co. and Westinghouse's Bettis plant, and 3) production of the cups at Bettis, with detailed procedure for extrusion.

Boron carbide irradiation Effect of Irradiation on Hot-Pressed Boron Carbide. *W. D. Valovage. Knolls Atomic Power Lab. Nov 15, 1955. 45 pp.**

Hot-pressed boron carbide was irradiated in a vacuum, in helium, and in sodium to determine the quantity of helium released and the physical stability of this material after burnups as high as 36% of the B^{10} atoms. It was found that extensive physical damage occurs, beginning with loss of hardness and cracking after very low burnup and increasing with burnup until, at 36% burnup, complete granulation results. At each level of burnup investigated, specimens irradiated in sodium were damaged more extensively than specimens irradiated in vacuum or in helium.

Plating reactor metals Electrodeposition of Beryllium, Thorium, and Zirconium from Fused-Salt Baths. *J. A. Gurklis, J. G. Beach and C. L. Faust. Battelle Memorial Inst., Nov 4, 1952. 26 pp.**





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like toothpaste out of a tube

Yes, it's just as quick as that. The production of intricate precision parts by the Harper extrusion method. They flow through the die like toothpaste from a tube.

The process is so flexible it is able to handle small orders fast. Die costs are low.

Copper-base alloys, carbon steels, alloy steels, as well as the tougher stainless steels, heat-resistant alloys and even titanium, can be extruded because glass is used as a lubricant. Check these advantages:

Machining reduced or eliminated
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Other Harper Divisions

The Bolt Division offers over 7000 individual fastening items—bolts, nuts, screws, rivets, washers of brass, bronze, monel, stainless and aluminum in stock ready for shipment. Special parts by the Harper "Flo-Form" method can be produced economically.

The Aero Division produces all types of fastenings from high-temperature metals and titanium. Years of experience in working with tough metals give our engineers a valuable background that is available to you. Write for information.

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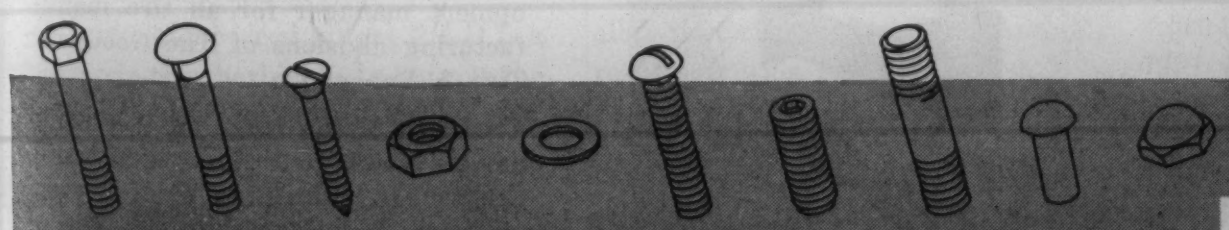

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- Friction Materials
- Seed Cleaning
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FABRICATORS!

A test sample of the NIAGARA 100 MESH IRON POWDER will prove to you that you CAN eliminate dimensional growth problems on iron-copper parts.

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GAR

GAR-FORMING is a unique electroforming process. It reproduces full-formed metal parts in any quantity to extraordinary accuracy and surface finish. Gar-forming is specially useful where precise, intricate part interiors are required. Please describe your problem when requesting data.

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NEWS OF ENGINEERS COMPANIES SOCIETIES

Eugene C. Clarke, Jr., has been elected president of Chambersburg Engineering Co.

Robert B. Boswell has been named divisional chief engineer in the newly organized Forge and Foundry Div., Chrysler Corp.

Robert Rulon Miller has assumed the presidency of Dixon Corp.

O. H. Davol, formerly chief engineer, General Engineering Dept., Electro Metallurgical Co., has been appointed manager of that department. Also promoted in the same department were **S. S. Blackmore** to assistant manager, and **H. M. Huse** to consulting engineer.

David E. Deutsch has joined the technical staff of Fansteel Metallurgical Corp. as senior metallurgist.

Dr. S. C. Ogburn, Jr., vice president —Research and Development, Foote Mineral Co., has retired. He will continue to serve the company as a management consultant.

Dr. Heinz G. F. Wilsdorf, principal research officer, National Physical Laboratory, Council for Scientific and Industrial Research, Pretoria, Transvaal, Africa, will join the staff of The Franklin Institute early in the summer as senior research metallurgist in the Solid State Physics Div.

Arthur C. Treece has been appointed general manager of General Electric Co.'s Plastics Dept. to succeed **John L. McMurphy** who has been named manager of a special study-team on the Chemical and Metallurgical Div.'s insulation businesses.

Hicks B. Waldron has been made manager-manufacturing engineering for GE's Distribution Assemblies Dept.

Jesse L. Powers has been advanced to general manufacturing manager, Buick Motor Div., General Motors Corp.

John J. Hartz has been made development manager for all tire manufacturing divisions of The Goodyear Tire & Rubber Co.

Frederick M. Rutledge has been appointed chief control engineer, and **Crayton H. Schwestka** chief design engineer, The Hays Corp.

(More News on p 268)

Man without a hoe

This cornfield once looked hopelessly over-grown with weeds.

Now the weeds are under control. *Yet not a single hoe ever touched the soil.*

Give the credit to 2,4-D, an amazing chemical discovery. It destroys only broad-leaved weeds. And gives food plants like corn, wheat, rice, oats and barley a new lease on life!

Unlike older weed killers, 2,4-D is a hormone-type herbicide. It disrupts the normal growth of broad-leaved weeds. In three or four weeks, they're *dead.*

What's 2,4-D? Actually, 2,4-dichlorophenoxyacetic acid. And there were tough problems to overcome at nearly every stage of its development.

Corrosion, for example, was a constant threat to the life of equipment — and to the purity of the final product. So Nickel and Monel* nickel-copper alloy are specified for pipes and fittings, steam coils, reactors, centrifuges, dryers, tanks and other equipment used in making and handling 2,4-D.

Nickel and Monel nickel-copper alloy protect product purity. And they resist corrosion as few metals do!

Tuck that information away where it will be handy. You may be able to use it in solving a problem of your own.

Better still, do this — now. Send for "Standard Alloys for Special Problems." This booklet summarizes the properties, applications and available forms of all the Inco Nickel Alloys. Write us for a copy. Use it to help you select the most suitable metal for *your* job. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

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NYLON PRODUCTS

Facilities include experienced Design and Engineering of new parts and assemblies, and those to be converted to Nylon. We can help you determine the feasibility of conversion to Nylon—especially where metal-to-metal contact or wear is presently involved.

Component Parts and Assemblies expertly molded from Nylon—on a production manufacturing basis, or experimental work. From thin wall to thick wall parts. Fabrication facilities available. Prompt attention to all inquiries. Samples sent on request.

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SPECIALISTS IN MOULDING
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For more information, Circle No. 601

news of | ENGINEERS

Dr. John M. Snider has assumed charge of The Henry Co.'s research into high temperature sealants for the aircraft and guided missiles industry.

Rame W. Bull has been named supervisor of electronic instrumentation, Electrical Engineering Research Dept., Armour Research Foundation of Illinois Institute of Technology. Other new appointments in the Foundation include **Alfred Ritter** as supervisor of hydrodynamics, Propulsion and Structural Research Dept., and **Edwin A. Swire**, supervisor of organic and polymer research, Chemistry and Chemical Engineering Research Dept.

Wilbur E. Kelley has been elected president of Walter Kidde Nuclear Laboratories, Inc.

Joseph P. Crosby, vice president and director, The Lapointe Machine Tool Co., has been appointed director of the Metal-Working Equipment Div., Business and Defense Services Administration, U. S. Dept. of Commerce.

Fred H. Hehemann, chief engineer of Lunkenheimer Co., has retired after 52 years with the company.

Dr. John G. Thompson has retired from his position as chief of the Metallurgy Div., National Bureau of Standards.

news of | COMPANIES

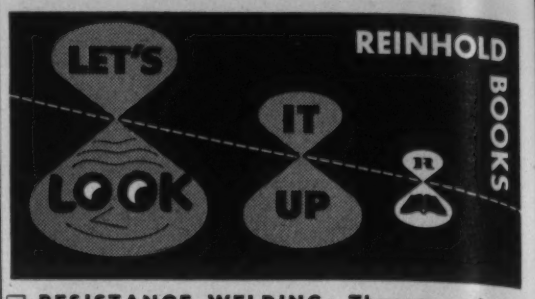
Alan Wood Steel Co. has authorized the construction of a new factory for its Penco Metal Products Div. at Oaks, Pa.

Albany Products Co., Inc., Connecticut Ave., South Norwalk, Conn., has been founded to manufacture headed, machined and forged fasteners made from corrosion and heat resistant alloys.

American-Marietta Co. and **The Presstite Engineering Co.** have approved an agreement providing for the sale of the entire assets and business of Presstite to American-Marietta.

Borden Co. recently announced that it is constructing a new polyvinyl chloride resin plant at Leominster, Mass.

(More News on p 270)



☐ **RESISTANCE WELDING: Theory and Use** *by the Resistance Welding Committee, American Welding Society.* Compiled by leading experts in the field. Covers principles, definitions of terms, processes, machines, controls, electrodes, jigs and fixtures, welding symbols, weldability of metals, precautions required, weld quality, specifications, control, and the welding of aluminum.
1956, $4.50

☐ **SODIUM, Its Manufacture, Properties and Use** *by Marshall Sittig.* Combines latest developments in the manufacture, handling and use of sodium with a critical coverage of its physical, chemical and thermodynamic properties. Amply supplied with flow sheets, equipment illustrations and photos of actual sodium handling operations. Contains over 2,000 references to published literature.
ACS Monograph, 1956, about $8.00

☐ **POLYESTERS AND THEIR APPLICATIONS** *by Bjorksten, Tovey, Harker and Henning.* The first comprehensive survey of the polyester field from raw materials to fabricated products. Text plus over 3,300 references cover almost every phase of the production and use of polyesters including saturated polyesters used in the production of fibers, films, elastomers and foamed plastics.
1956, $10.00

☐ **BRAZING MANUAL** *by the Committee on Brazing and Soldering, American Welding Society.* Describes the principles, equipment and procedures involved in the 8 major brazing processes; each operation from surface preparation to postbraze inspection; and techniques of brazing aluminum, magnesium, copper, steels, nickel and many other metals. 1955, $4.75

☐ **ELECTROPLATING ENGINEERING HANDBOOK** *edited by A. K. Graham.* Brings you newest information on processing techniques and the engineering factors involved in constructing and installing plating equipment. Covers the design of parts to be plated, specifications, processing sequences, testing, maintenance, waste treatment, and much, much more. 1955, $10.00

☐ **HANDBOOK OF BARREL FINISHING** *by Ralph F. Enyedy.* Covers every phase of barrel finishing from cleaning and deslugging to coloring, polishing and burnishing in step-by-step sequence. More than 150 complete specification sheets provide all the information necessary for finishing a large variety of parts. 1955, $7.50

☐ **COPPER** *edited by Allison Butts.* Treats almost every phase of the chemistry and metallurgy of copper, its alloys and compounds. Full chapters describe copper minerals and ore deposits; smelting, converting and refining; melting and casting; physical and chemical properties; hot and cold working; binary and ternary copper alloys; and uses of the element in chemistry, biology and agronomy.
ACS Monograph, 1954, $20.00

☐ **TITANIUM AND TITANIUM ALLOYS** *by J. L. Everhart.* Summarizes and coordinates the extensive periodical literature which has appeared since titanium became of commercial significance. Emphasizes the properties, fabrication, machining and applications of commercial titanium and those alloys now in production. 1954, $2.95

☐ **ADHESIVE BONDING OF METALS** *by George Epstein.* Shows how to determine if an adhesive-bonded joint would be advantageous, what type of adhesive to select, how to employ it, and how to design the joint for best performance. Covers the chemistry, formulation, and factors affecting the strength of adhesive bonds. 1954, $2.95

☐ **SHELL MOLDING AND SHELL MOLD CASTINGS** *by T. C. DuMond.* Explains how the process works and the advantages to be obtained from shell mold castings. Invaluable to everyone who must determine when, where, and how such castings might best be used. 1954, $2.00

☐ **RARE METALS HANDBOOK** *edited by Clifford A. Hampel.* Latest available data on over 30 of the less-common metallic elements — previously little investigated but now playing most important roles in modern technology. Information on each element is arranged for quick reference to such important aspects as occurrence, production statistics, economics, derivation, physical and chemical properties, fabrication techniques, alloys and applications. 1954, $12.00

☐ **FABRICATED MATERIALS AND PARTS** *by T. C. DuMond.* A comparison of cost and design factors to help you select the *right* metal-forming methods for the greatest economy in manufacturing small industrial parts. Contains a valuable fold-out chart (over 2½ feet long) showing at a glance the cost, design and production comparisons between various manufacturing methods. This chart alone is worth many times the book's cost to production men. 1953, $6.50

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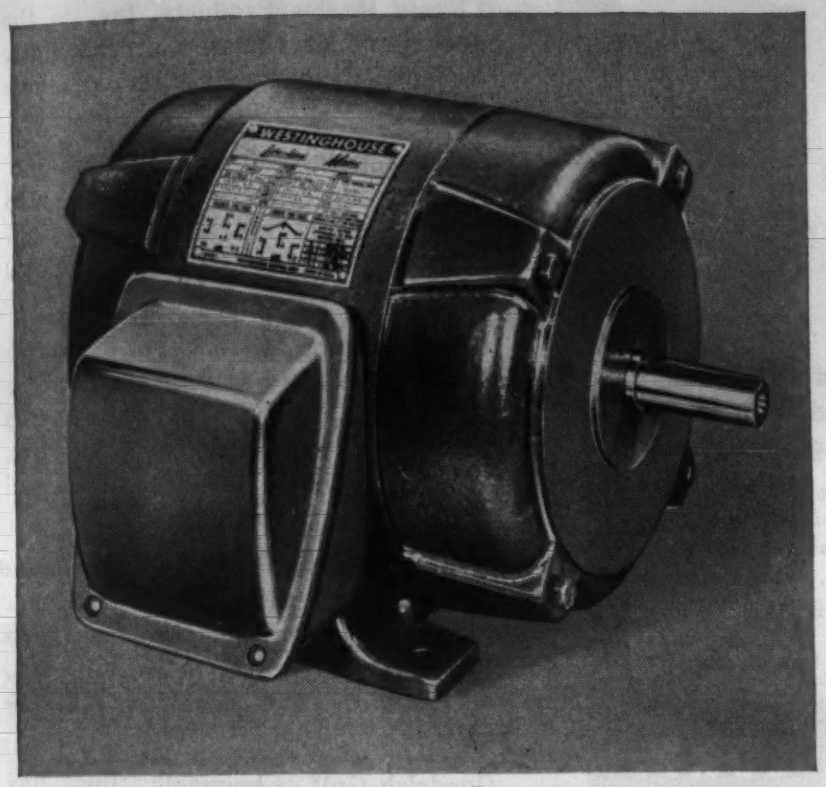

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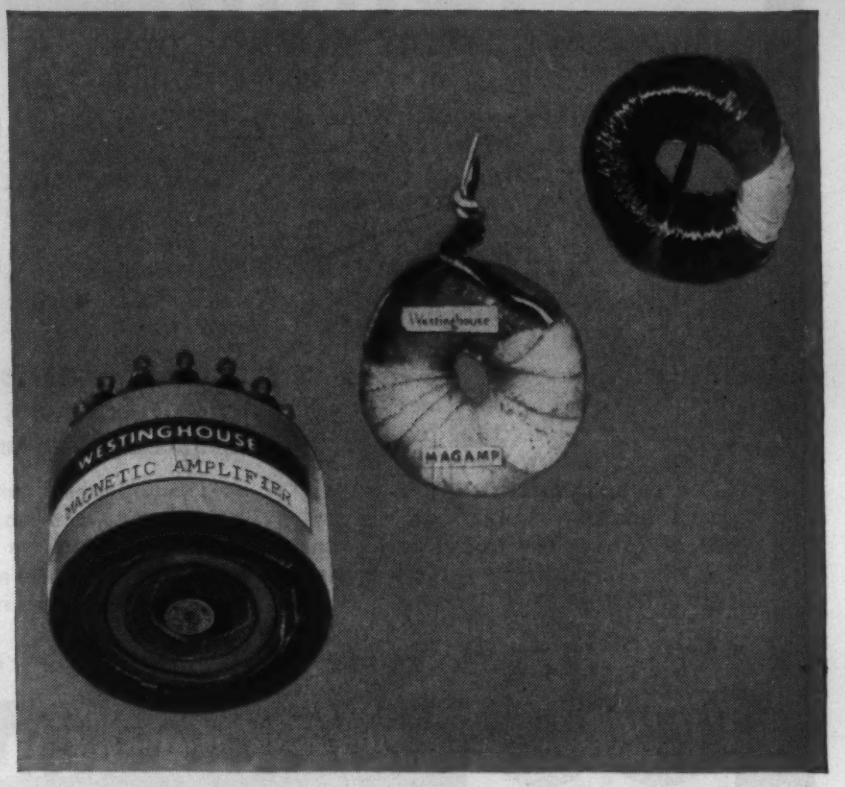

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For more information, turn to Reader Service Card, Circle No. 581

news of COMPANIES

Bridgeport Brass Co. has acquired all the outstanding shares of **Hunter Douglas Aluminum Corp.** stock in exchange for 270,000 shares of Bridgeport Brass common stock.

Clevite Harris Products, Inc., is the new name of Clevite Corp.'s wholly owned subsidiary, **Harris Products Co.**

Climax Molybdenum Co.'s pure molybdic oxide capacity will be doubled by the installation of a second sublimation furnace at its Langeloth, Pa., plant.

Crane Co. and **Vitro Corp. of America** have entered into a joint operation to produce thorium, rare earths and heavy minerals from monazite, as well as rutile, ilmenite, zircon and kyanite.

General Electric Co.'s Medium Steam Turbine, Generator and Gear Dept. has established a Materials and Processes Laboratory at Lynn, Mass., with testing facilities valued in excess of $750,000.

Goodrich-Gulf Chemicals, Inc., has launched a modernization program at its Institute, W. Va., synthetic rubber plant now that Congress has approved sale of the facility by the government.

The Holo-Krome Screw Corp. has revealed the completion of a new Research and Development Div. on the grounds of the West Hartford, Conn., factory.

International Harvester Co. has announced a plant modernization and improvement program for its Wisconsin Steel Works to cost almost $10 million.

Kaiser Engineers, Div. of Henry J. Kaiser Co., has reached an agreement with **Jones & Laughlin Steel Corp.** on a licensing arrangement that will allow J&L to use the new oxygen converter process for making steel.

The **M. W. Kellogg Co.** has moved into a new building at 711 Third Ave., New York City.

Koppers Co., Inc., announced the following first-prize winners in a nationwide design competition for molders of plastics housewares: Federal Tool Co.; C. B. Cotton & Co., Inc.; Bu-Gay Plastic Products, Inc.; and Columbus Plastic Products, Inc. Columbus Plastic was awarded the "Best of Competition."

(More News on p 272)

INTRODUCING the ultimate in low cost, high flex modulus

Bigelow Lamimat*

ANNOUNCING — one of the most important innovations in the whole field of plastics . . . a superb new reinforcing material developed by the *leader* in fiber blending — Bigelow. It provides the answer to the major problem of molders and laminators of reinforced plastics — how to achieve high flexural modulus at low cost with light weight. The answer — in a word is — LAMIMAT.

BIGELOW
Fiber Glass Products

What Lamimat is — A drapeable, uniform, lightweight mat with a blended organic-glass core and an all-glass face.

What Lamimat does — Enables you to build *thicker sections with high flexural modulus and considerably less weight* than when using mats of all-glass fibers.

How Lamimat saves you money —

1. *More Bulk for the Money.* Pound for pound, Lamimat provides more necessary volume than do all-glass mats . . . but costs no more!

2. *You Use Less Material.* Because Lamimat is lighter and bulkier, you use less poundage of reinforcing material and less resin to achieve the same thickness as when molding with all-glass mats.

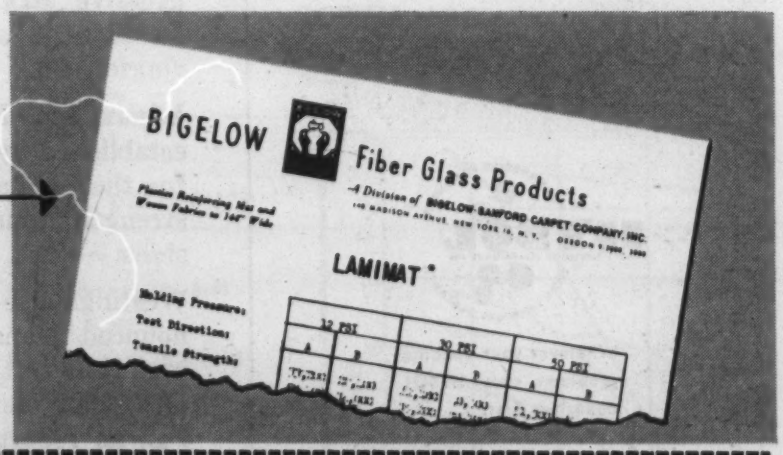
3. *Puts Strength Only Where You Need It.* Allows you to design more efficiently, without using wasteful excess material or unnecessary strength in other areas.

4. *Cuts Down Fabricating Costs.* Because Lamimat can be fabricated in thicker sections at the start, it eliminates necessity for costly processing or adding layer on layer to achieve thickness.

And if lightness is a strong selling point in your product — Lamimat's low specific gravity gives you a laminate that is light — yet strong.

Whatever you're molding, Lamimat can simplify your job, solve production problems to your complete satisfaction. **Send for technical data sheet and free samples.**

See us in Booth 942 — 7th National Plastics Exposition, New Coliseum, N. Y. C., June 11-15



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New HYSOL Adhesive Improves Laminates For Printed Circuit Systems

- ***DOUBLES*** **Bond Strength**
- ***INCREASES*** **Solder Temperatures**

Now, printed circuit temperatures are no longer limited by the bonding agent, but only by the base material itself. Copper clad laminates, using the HYSOL 2217 system eliminates the need for low solder temperatures which result in poor reliability. Higher temperatures provide improved reliability, reduce soldering cycles, and increase production. And HYSOL 2217 bond strength is double that of any other process.

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news of | COMPANIES

The James F. Lincoln Arc Welding Foundation is offering $20,000 in 20 cash awards for ideas or suggestions that will accelerate progress in arc welding. Ideas must be submitted by July 30, 1956.

Lindberg Industrial Corp. has purchased the good will, drawings and other assets of the **Jet Combustion Co.** Operations of both companies will be merged at the Lindberg plant.

Metal Hydrides Inc. has completed negotiations for underwriting an intensive research program to develop new production techniques for thorium metal powder.

Minnesota Rubber & Gasket Co. has begun construction on its $500,000 project which will increase present facilities by about 32,000 sq ft.

Mobay Chemical Co. has announced that its new chemical plant will be tripled in size as rapidly as engineering and construction can be completed.

The New Jersey Zinc Co. has concluded arrangements for the acquisition of **American Cyanamid Co.'s** plant at Gloucester City, N. J., which will be used for the manufacture of titanium dioxide pigments.

Nopco Chemical Co. has begun work on its new plant in North Arlington, N. J., to be used in the production of foamed plastics.

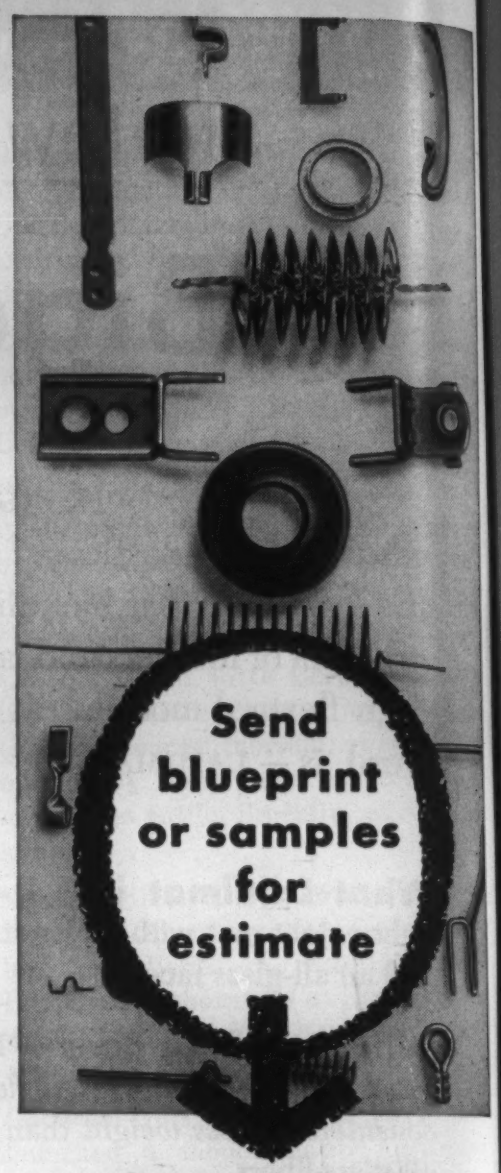
The Torrington Co. has purchased the business and assets of **The Progressive Mfg. Co.** Progressive will function as a division of The Torrington Co.

Impax, Inc., Ferguson, Mo., has been established by Universal Match Corp. for the production of precision, high strength aluminum impact extrusions.

Westinghouse Electric Corp. has announced plans to build its nuclear materials testing reactor near **Waltz Mill, Pa., instead of at Blairsville, Pa.,** as reported previously.

news of | SOCIETIES

The American Institute of Electrical Engineers, in cooperation with the American Physical Society, the American Institute of Mining & Metallurgical Engineers, and the Institute of Radio Engineers, has an-



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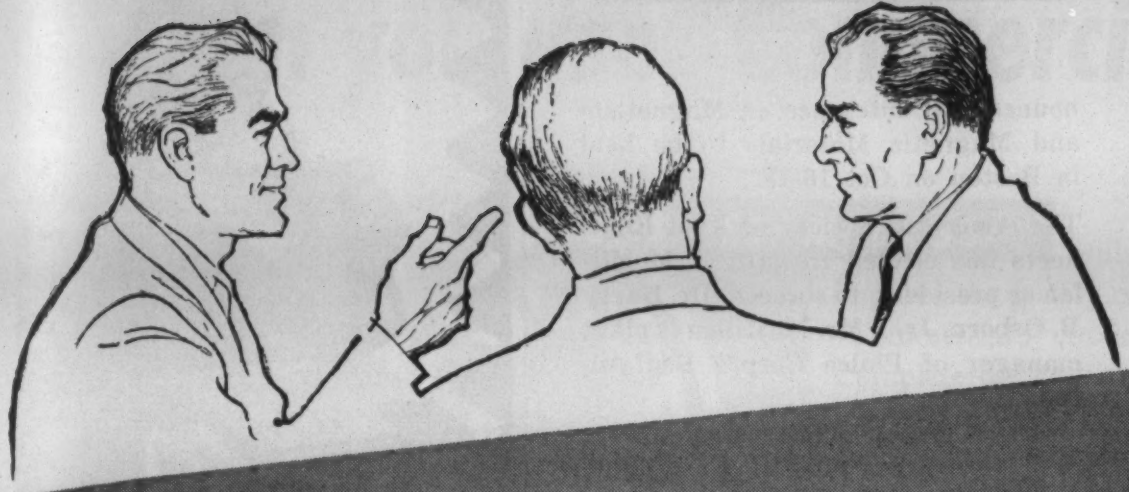
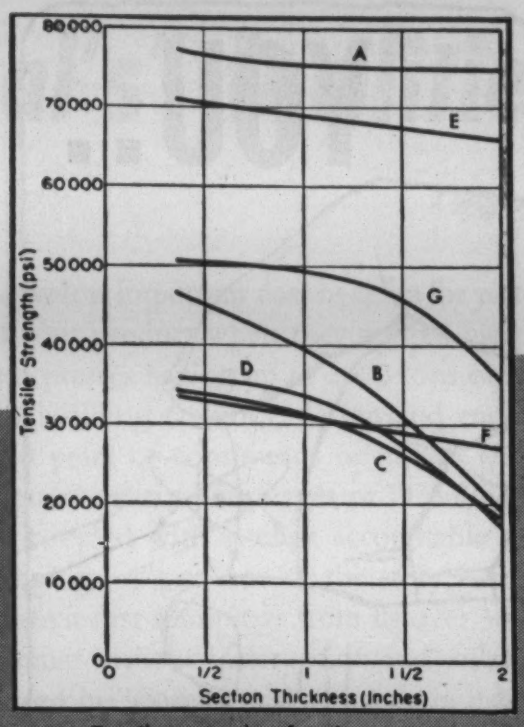


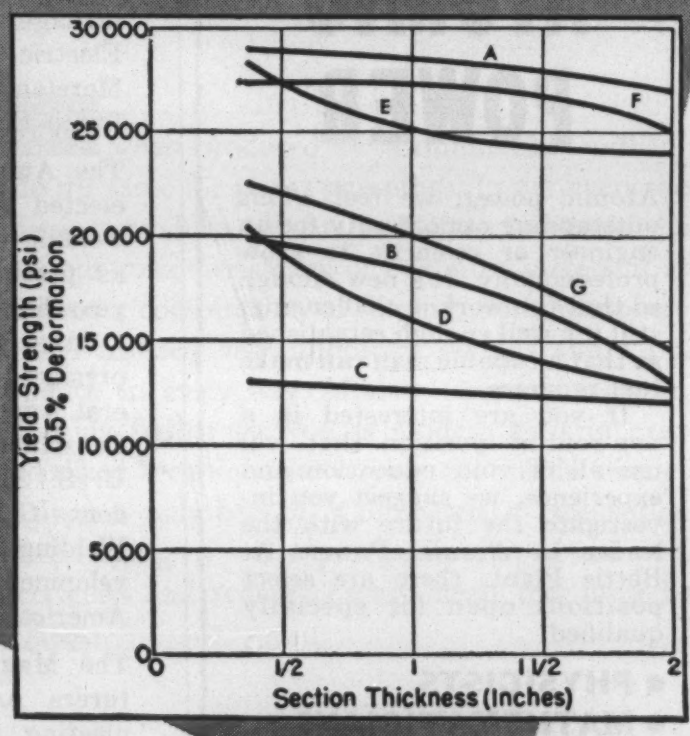
Here's proof....

that you can use lighter sections, have greater strength, improve your product, save money

with **AMPCO*** **Metal**



Tensile strengths of various non-ferrous metals vs. section thickness



Yield strengths of various non-ferrous metals vs. section thickness

Examine these charts carefully — they tell a story that can save you money and put extra life and dependability into your product.

Look, for instance, how other non-ferrous metals show a sharp decrease in mechanical values as casting cross-sections increase. Ampco remains practically constant — you require less metal.

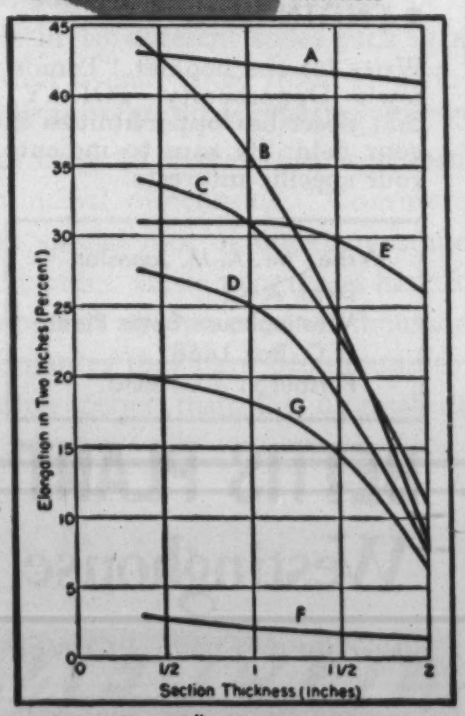
Note Ampco's unusually high tensile and yield strengths compared with conventional bronzes — you use lighter sections to do a better job. And Ampco Metal weighs 10 to 15 percent less than other bronzes — so you can make important weight reductions.

Fact is, Ampco Metal's high strength-to-weight ratios can mean real savings for you — savings in material and money. Consult your nearby Ampco field engineer for full information or write us.

CHART REFERENCE

- A. Ampco Metal
- B. Tin Bronze (88-8-4)
- C. Red Brass
- D. Tin Bronze (85-5-5-5)
- E. Manganese Bronze
- F. Aluminum Alloy
- G. Silicon Bronze

Charts courtesy Materials & Methods and Westinghouse Electric Corp.



Elongations (2") of various non-ferrous metals vs. section thickness

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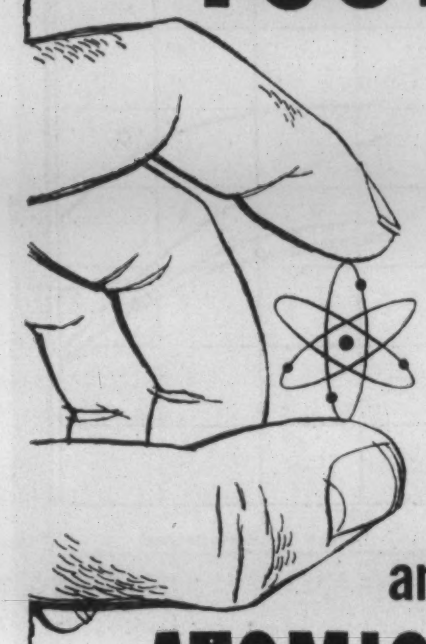

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news of | SOCIETIES

nounced a Conference on Magnetism and Magnetic Materials to be held in Boston on Oct 16-18.

The **American Society of Tool Engineers** has elected Howard C. McMillen as president to succeed Dr. Harry B. Osborn, Jr. Mr. McMillen is plant manager of Philco Corp.'s Bedford, Ind., plant.

Other society officers elected are: first vice president—H. E. Collins, manager, Process Engineering Dept., Hughes Tool Co.; second vice president—G. A. Goodwin, chief process engineer, The Master Electric Co.; third vice president—Wayne Ewing, president, Arrowsmith Tool and Die Co., Inc.; fourth vice president—H. Dale Long president, Scully-Jones & Co.; treasurer—John X. Ryneska, manager of purchasing, General Electric Co.; secretary — William Moreland, vice president, Meyers Pump Co.

The **American Welding Society** has elected John J. Chyle, director of welding research, A. O. Smith Corp., as president for the 1956-57 fiscal year beginning June 1.

Other new officers are: first vice-president—Clarence P. Sander, general superintendent, Vernon Plant, Consolidated Western Steel Div., U. S. Steel Co.; second vice-president—Gustav O. Hoglund, head of Welding Section, Alcoa Process Development Lab., Aluminum Co. of America.

The **Magnesia Insulation Manufacturers Assn.**, at its recent annual meeting, re-elected Ernest Muehleck, president of Keasbey & Mattison Co., as chairman of the board of governors.

The **Pressed Metal Institute** has presented the 1956 John Woodman Higgins Redesign Award to Francis B. Lord, owner of Lord Machine Co. The $500 prize is donated annually by Worcester Pressed Steel Co.

The **Rubber Manufacturers Assn.'s** O-Ring Manufacture Subdivision recently named Thomas B. Keenan, executive vice president, Plastic and Rubber Products Co., as chairman for the group, and F. A. Lewis, Linear, Inc., as vice chairman.

The **Ultrasonic Manufacturers' Assn.** has been formed to promote dissemination of accurate information about ultrasonic equipment and its applications.

(Meetings & Expositions on p 276)

For more information, Circle No. 516

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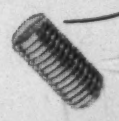
...like these



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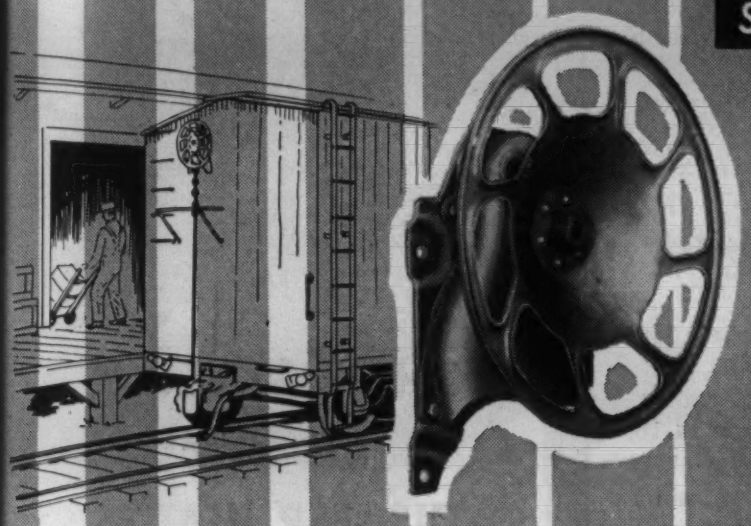

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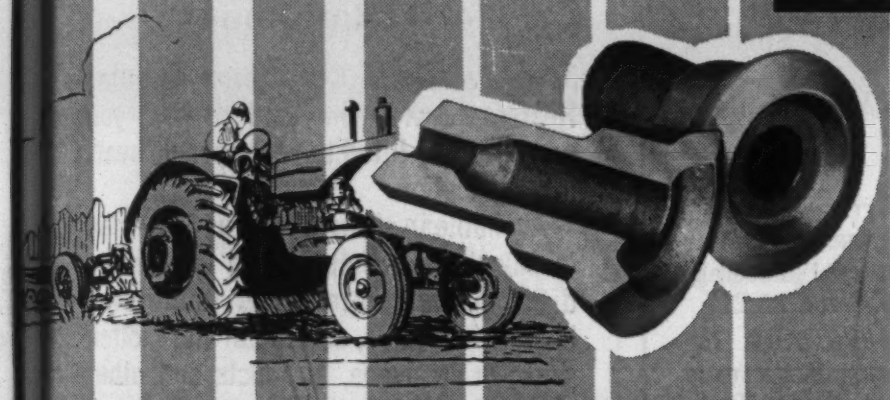

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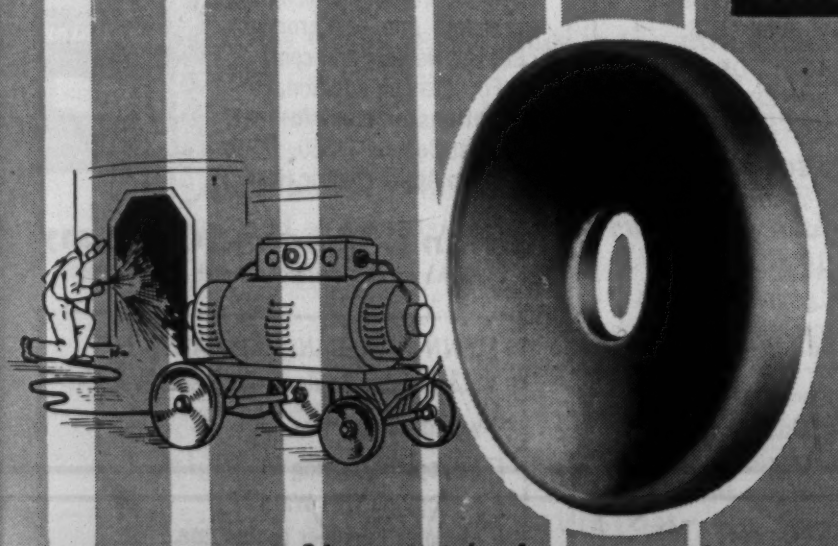

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Meetings and Expositions

PORCELAIN ENAMEL INSTITUTE, mid-year divisional conference. Chicago. May 16-18.

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting. Atlantic City. June 3-8.

AMERICAN SOCIETY FOR QUALITY CONTROL, annual convention. Montreal. June 6-8.

MALLEABLE FOUNDERS' SOCIETY, general meeting. Hot Springs, Va. June 11-12.

NATIONAL PLASTICS EXPOSITION, SOCIETY OF THE PLASTICS INDUSTRY, New York. June 11-15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Applied Mechanics Div. conference. Urbana, Ill. June 14-16.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Cleveland. June 17-21.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City. June 18-22.

ALLOY CASTING INSTITUTE, annual meeting. Hot Springs, Va. June 24-26.

DROP FORGING ASSN., annual meeting. Hot Springs, Va. June 24-27.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer and Pacific general meeting. San Francisco. June 25-29.

SOCIETY OF THE PLASTICS INDUSTRY, Plastic Structures Div. conference. New York. June 26.

PORCELAIN ENAMEL INSTITUTE, porcelain enamel on aluminum conference. Cleveland. June 27.

SOCIETY OF AUTOMOTIVE ENGINEERS, West Coast meeting. San Francisco. Aug 6-8.

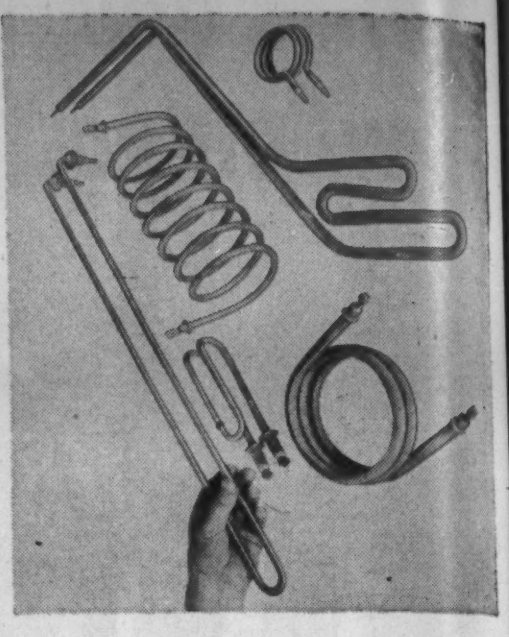
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, fall meeting. Denver. Sep 10-12.

SOCIETY OF AUTOMOTIVE ENGINEERS, tractor meeting and production forum. Milwaukee, Wis. Sep 10-13.

AMERICAN DIE CASTING INSTITUTE, annual meeting. Chicago. Sep 11-13.

AMERICAN SOCIETY FOR TESTING MATERIALS, Pacific Coast meeting. Los Angeles. Sep 16-22.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments and Regulators Div., and Instrument Society of America, exhibit and joint conference. New York. Sep 17-21.



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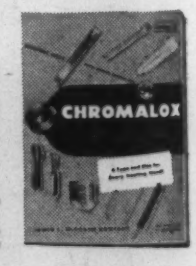

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MATERIALS ENGINEERING NEWS

(Continued from p 13)

consumption of aluminum in making zinc die casting alloys.

More than 75% of total die casting requirements for aluminum was supplied by the smelting industry. Primary aluminum supplied to the die casting industry in 1955 increased in the latter part of the year when stockpile requirements were reduced. Earlier availability of aluminum would have made possible even higher die casting use.

Use of slab zinc for die casting is estimated at 410,000 tons, 40% of total slab zinc production. Last year saw special high grade zinc exceed any other slab zinc grade in total use, displacing prime western for the first time. Since special high grade slab zinc carried a premium of $30 per ton (now $35), die casting has assumed increasing importance in the economics of the zinc industry.

ASTM Groups Study Plastics, Other 'Specs'

With the markets for plastics pipe rapidly expanding, the need for standard test methods and specifications in this area is acute. Current efforts by the ASTM and the Society of the Plastics Industry to meet this need are centered in ASTM Committee D-20 on Plastics. While no standards are yet ready for recommendation to the ASTM as a whole, there are a number under development.

Work in this area and in many other critical fields was reviewed by 33 of ASTM's technical committees during the Society's annual Committee Week in Buffalo two months ago. Approximately 1300 technical men, holding 350 committee and subcommittee meetings, joined in discussions aimed at correlating the research work

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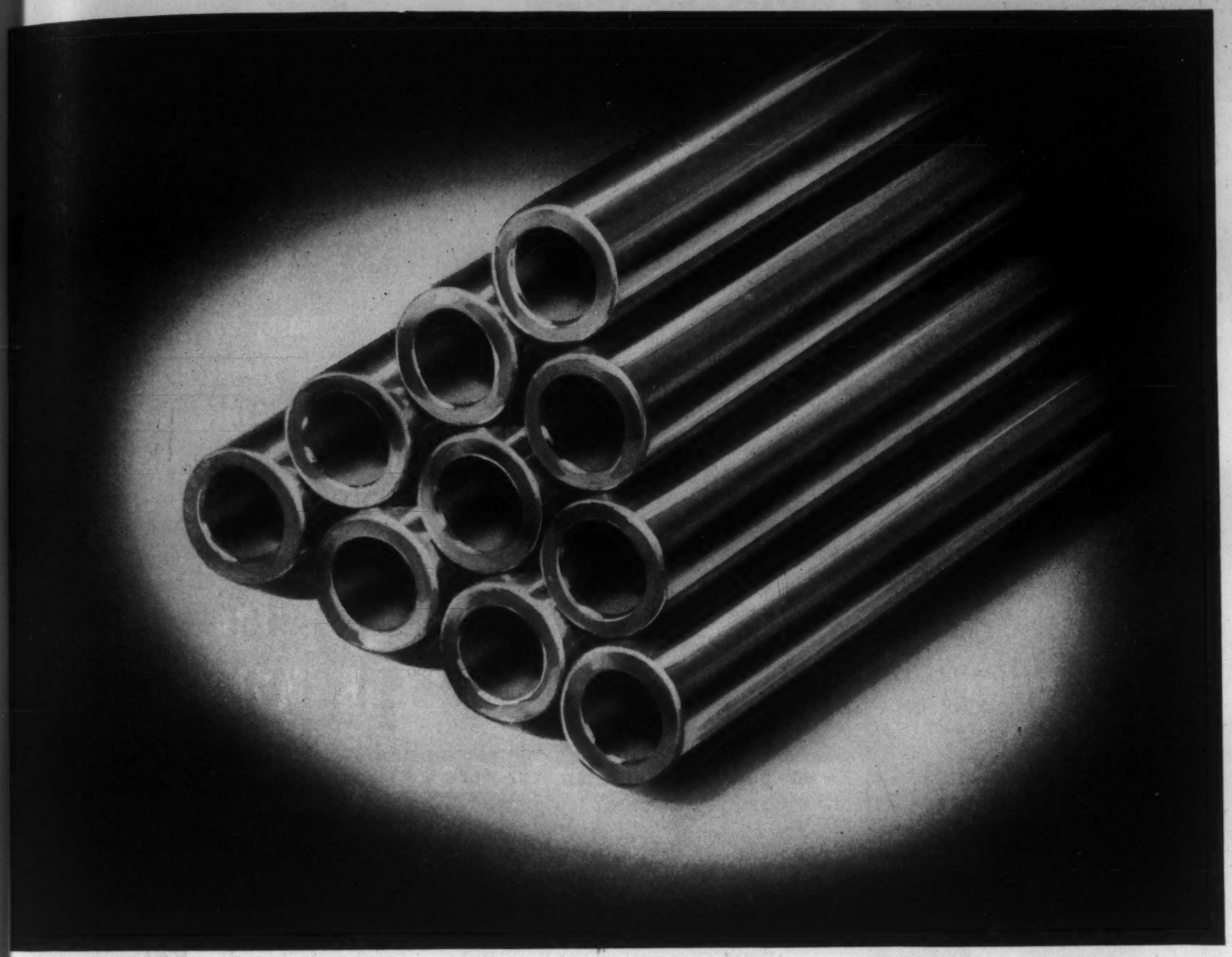

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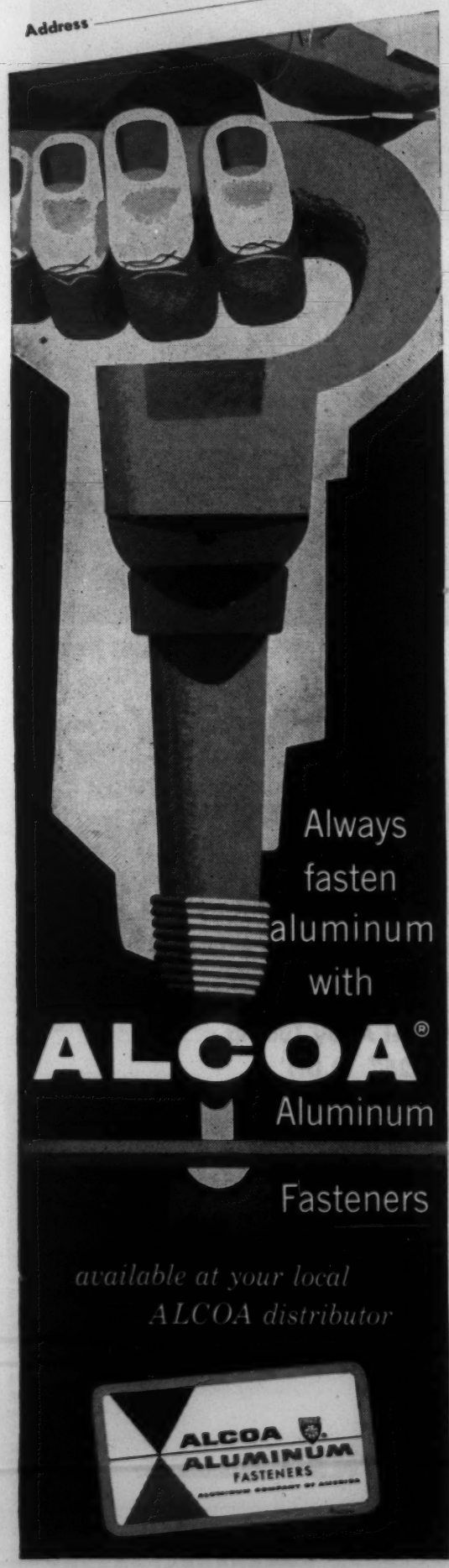

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MATERIALS ENGINEERING NEWS

on which ASTM specifications and test methods are based.

Other plastics work

Committee D-20's work on improving existing specifications for polyethylene has been complicated by the development of new types of polyethylene made by low pressure polymerization. A number of different names or designations for these types of polyethylenes have been proposed, leading to considerable confusion in the industry. Solution of the nomenclature problem is on the committee agenda.

Recognizing the importance of plastics in the industrial development of atomic power reactors, the committee established a group to study the effects of radiation on plastics. The group will work toward establishing recommended practices for exposure of plastics to radiation, as well as uniform methods for evaluating the effects and reporting the data.

Rubber materials

ASTM Committee D-11 on Rubber and Rubber-Like Materials,

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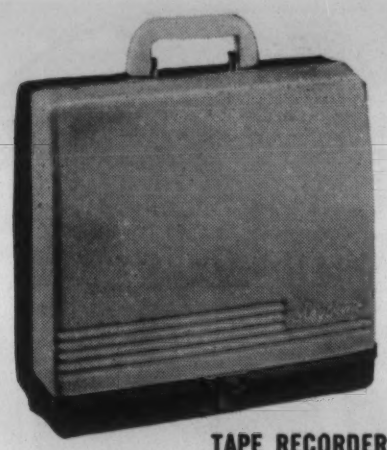

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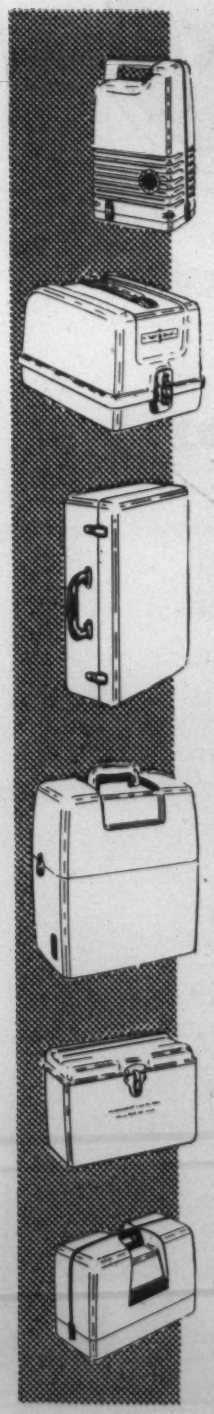

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MATERIALS ENGINEERING NEWS

announced that its "Glossary of Terms Relating to Rubber and Rubber-Like Materials", compiled by a special committee, will be ready for circulation soon. This glossary will contain definitions of over 2300 terms on rubber and the various materials used in its manufacture.

Another accomplishment reported at the meeting is completion of nine proposed tentative methods for the chemical analysis of synthetic elastomers. These methods represent the standardization work completed by the committee to date as an essential part of the Government Synthetic Rubber Program, formerly carried on under the jurisdiction of the Office of Synthetic Rubber of the Reconstruction Finance Corp. With the transfer of the former Government facilities to private industry, the responsibility for establishing standards for use in synthetic rubber manufacture was given to Committee D-11.

Porcelain enamel

Committee C-22 on Porcelain Enamel proposed a tentative method for a thermal shock test. Other new tests for porcelain enamels that were initiated include: gloss of porcelain enamel on curved surfaces, "enamelability" of enameling iron or steel, and resistance of porcelain enamel to steam and condensate.

The committee pointed out that, although the measurement of gloss on flat surfaces is an essentially simple operation, gloss measurement of enamel-lined tanks and special shapes demands special procedures. Likewise, despite the fact that enamelability of iron and steel is an important property to the steel consumer, its measurement and parameters are largely unknown.

Standards for metals

Working in a relatively new field, Committee D-7 on Light Metals and Alloys, Cast and Wrought continues to carry a

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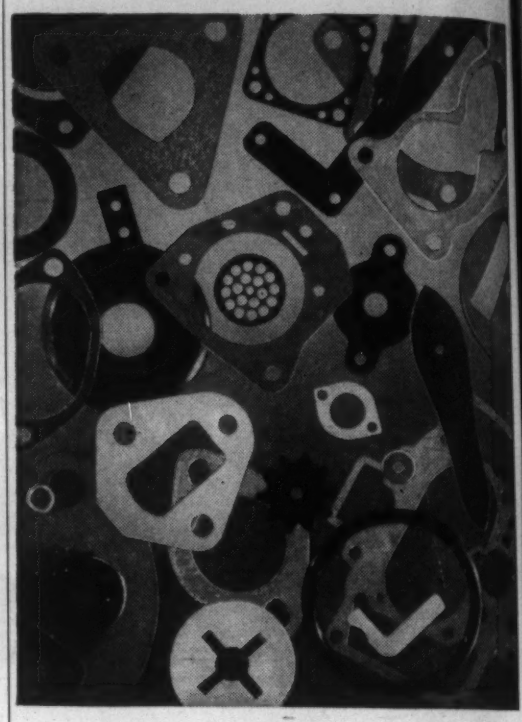

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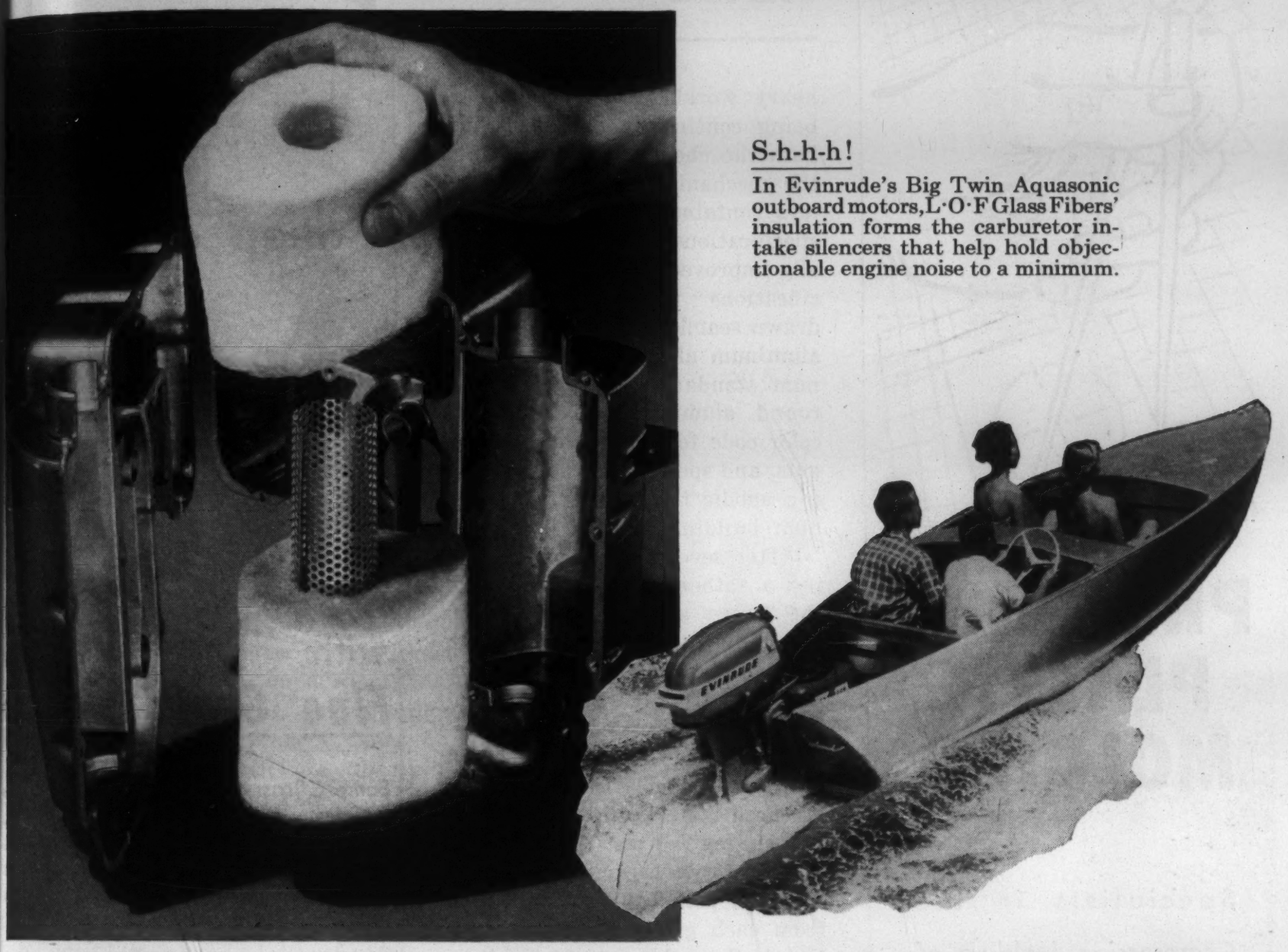

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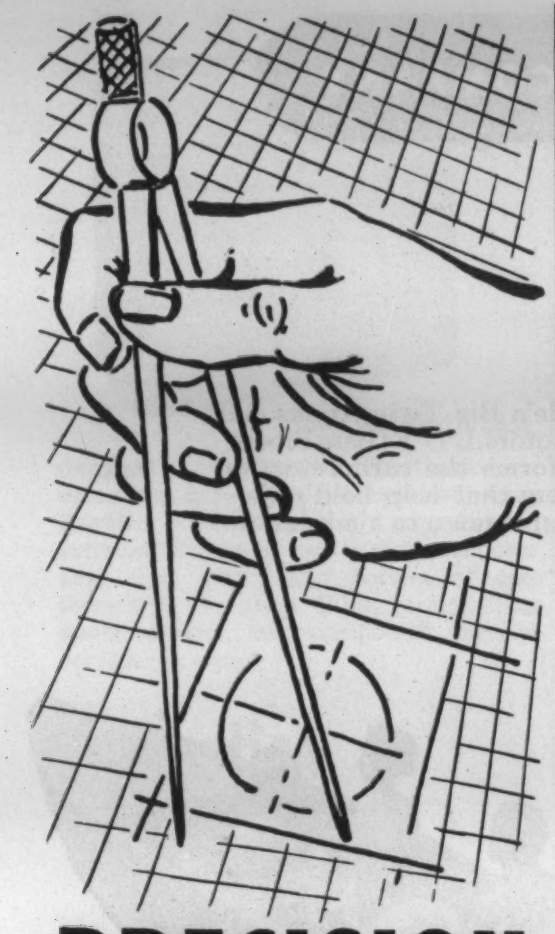

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MATERIALS ENGINEERING NEWS

heavy workload; new alloys are being continually developed, and both the chemical tolerances and the mechanical properties of alloys contained in current ASTM specifications are being continually improved. New tentative specifications underway include: drawn seamless aluminum tubing, aluminum alloy fasteners, aluminum standard structural shapes, round aluminum welded tubes, color code for aluminum alloy ingots, and specifications on producing anodic treatments for aluminum building panels.

After several years of developing a rather complete list of all the "super strength alloys" commercially available, together with their mechanical properties, Committee A-10 on Iron-Chromium-Nickel and Related Alloys reported that it is ready to begin work on specifications for many of these materials. The alloys in this survey fall into three groups, and prototype specifications will be developed first for one alloy from each group, then for additional alloys. Alloy 16-25-6 will be representative of hot cold-worked alloys, A226 of precipitation hardening alloys, and N 155 of casting alloys. After all of this preliminary work, however, there is still some question as to the correct definition of "super strength alloys", and the committee has appointed a task group to develop a specification which will have the approval of the entire group.

The advisory group of Committee A-3 on Cast Iron has taken

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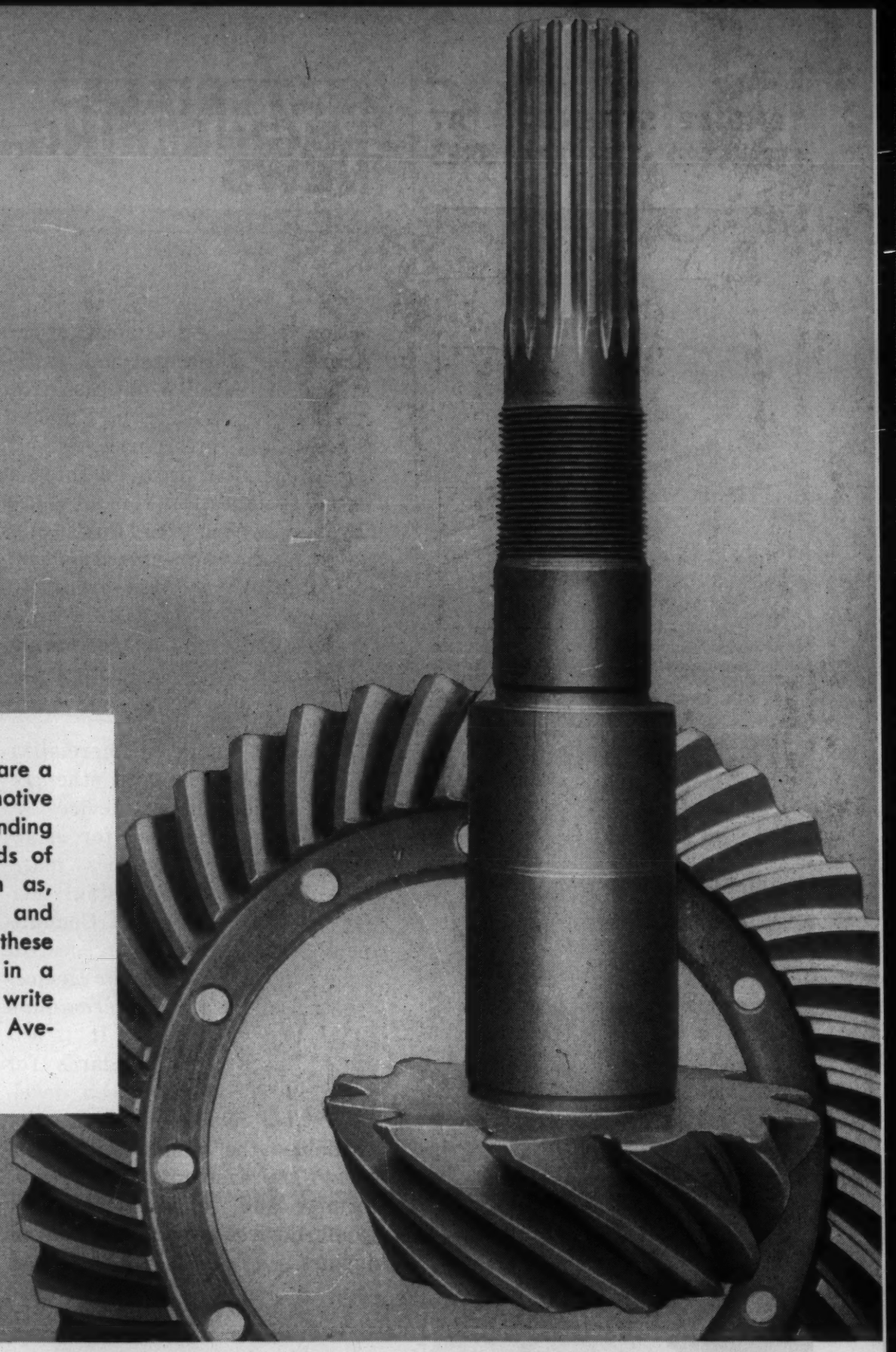

Moly carburizing steels with 0.5% Mo are a natural for components like this automotive ring-gear and pinion. They have outstanding properties that suit them to the demands of gearing and similar applications, such as, superior case hardness, low distortion and good machinability. Many features of these new carburizing steels are discussed in a recent technical article. For a reprint, write Climax Molybdenum Company, 500 Fifth Avenue, New York 36, N. Y., Dept. 6.

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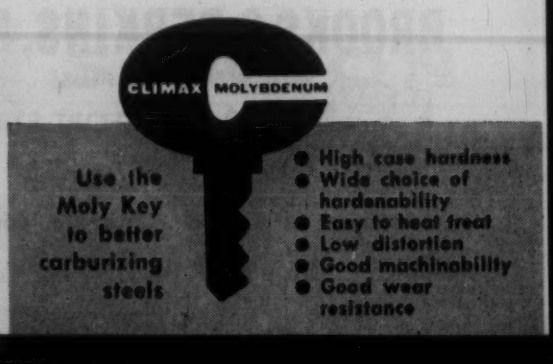

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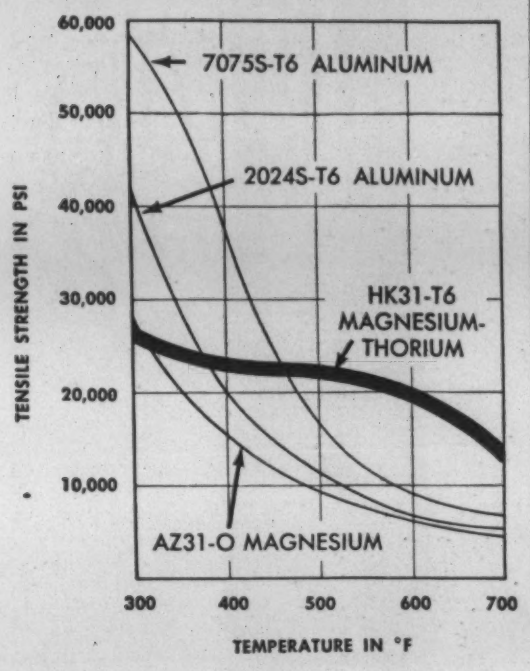

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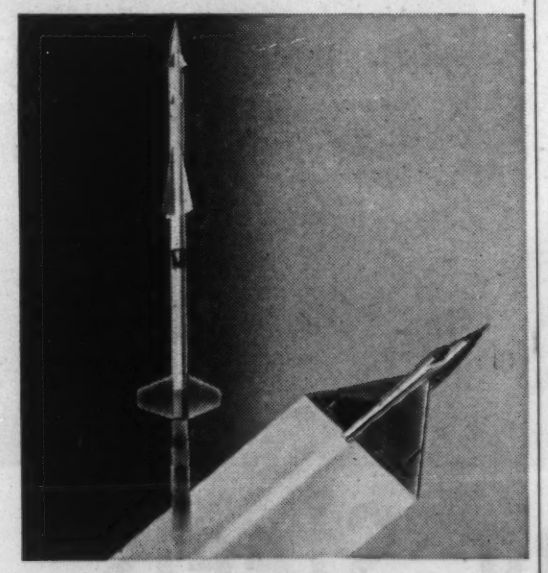

For designers of high speed jet planes, rockets, and guided missiles, this solves a problem. Formerly it was thought necessary to use heavy materials. They are less satisfactory than these magnesium alloys.

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MATERIALS ENGINEERING NEWS

action to expand American participation in international standardization activity on cast iron. At the last meeting in England, the United States participated in work leading toward an international specification for gray iron castings. International task groups have also been organized on malleable iron, nodular iron and methods of testing. Other work of the committee included formation of a new subcommittee on austenitic cast iron.

Electronic materials

With the rapid commercialization of transistors and other related semiconductor devices in recent years, the need for establishing standards for these materials has become increasingly evident. Present efforts of Committee F-1 on Materials for Electron Tubes and Semiconductor Devices are concentrated on germanium metal and its oxides. It is expected that when standards for these materials have been developed and are made generally available, the result will be a great improvement in the uniformity and reliability of electronic devices based on semiconductors.

Peck-Proof Plastics Poles

Plastics telephone poles may be the answer to the woodpecker problem plaguing utility companies. Manufactured by Gar Wood Industries, the glass fiber-reinforced polyester poles have been under test for over a year. Not only have the poles frustrated woodpeckers, but they also offer a superior defense against termites, fungi and other enemies of the wooden pole.

Experimental models weigh only 150 lb and can be easily installed by two men. The poles are hollow cylinders of 11 in. dia capped at each end. Cross-arms for the new

ENGINEERS

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Graph-i-tite

PROPERTIES	"Graph-i-Tite" A	"Graph-i-Tite" G
Apparent Density (lbs/ft³)	118	115
Tensile Strength (PSI)	2600	2500
Compressive Strength (PSI)	9000	8500
Transverse Strength (PSI)	4800	4400
Modulus of Elasticity (x 10^5)	21	18
Thermal Expansion (In/In/°F x 10^{-7})	11	9
Electrical Resistance (ohm-inches)	.00042	.00035
Thermal Conductivity (BTU/sq. ft/°F/hr/in)	1000	1100
Max. Temperature Resistance	1300°F	5700°F

GRAPH-I-TITE is a carbon-impregnated graphite. It is impermeable . . . non-wettable . . . non-contaminating . . . unaffected by thermal shock... Can be formed into pipe, cylinders, crucibles, molds, nozzles, and special shapes . . . Is immune to even the attack of dry chlorine at temperatures of 5000°F. . . . will provide rocket nozzle inserts of low erosion rates . . . may be produced sufficiently pure for use in atomic piles for transfer of fluids or heat and as a moderator.

Also, custom formulated graphite can be produced to meet your special purity, density, or other specifications. Extrusion, molding and machining facilities are available for one piece or high production runs.

Don't let old-fashioned materials restrict your thinking. Write today for additional information, and engineering help, if desired.

GRAPHITE SPECIALTIES CORP.

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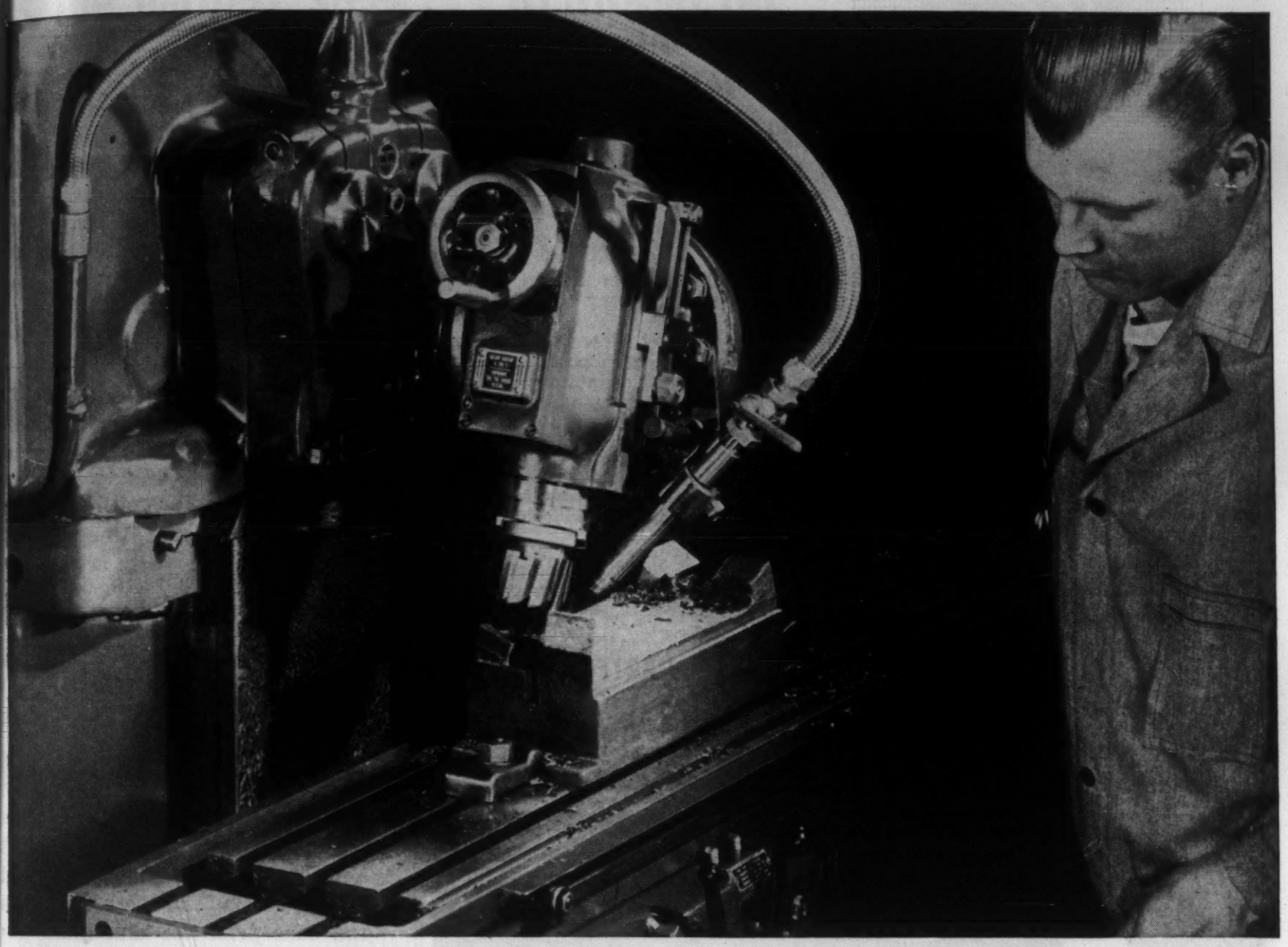
For more information, Circle No. 444

MALLORY·SHARON reports on

TITANIUM



GUARANTEES faster titanium machining

• Mallory-Sharon now guarantees that MST titanium and titanium alloy mill products contain no more than 1/10 of 1% carbon, maximum. Since larger percentages of carbon result in formation of hard carbides which greatly reduce machineability, this guarantee assures you that MST material has the optimum machining characteristics obtainable.

Thus you can machine Mallory-Sharon titanium faster, save production time and cost. In addition, this low carbon level assures improved notch toughness, fatigue properties, and uniformity of material. This new quality standard, another first from Mallory-Sharon, is made possible by "Method S" vacuum double melting.

Call us for your present requirements—or future plans—in titanium. For bulletin on Mallory-Sharon's new Titanium—6% Aluminum-4% Vanadium alloy write Dept. G-5.

MALLORY-SHARON TITANIUM CORPORATION, NILES, OHIO

VISIT US AT BOOTH 713

See corrosion demonstration

DESIGN ENGINEERING SHOW

MALLORY Ti SHARON

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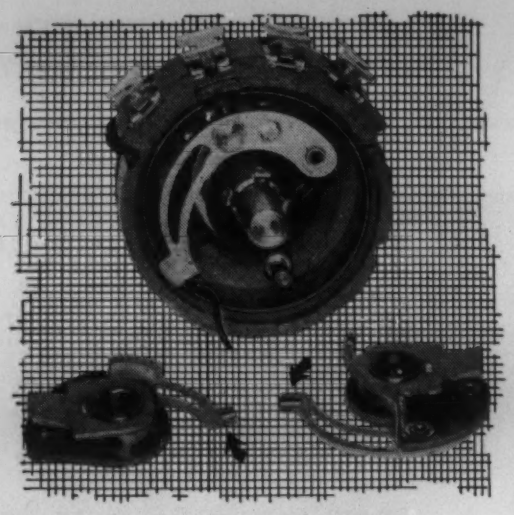

Arrows show Paliney #7 contacts used in this potentiometer manufactured by Clarostat Mfg. Co., Inc.

A BETTER WAY TO TRANSMIT ELECTRICAL SIGNALS in precision instruments

Paliney #7*, a Ney precious metal alloy, has been selected by Clarostat Mfg. Co., Inc., Dover, N.H., for use as wipers and sliders in their precision potentiometers. The use of this alloy assures long service and shelf life, excellent maintained linearity and low noise within close tolerances throughout the life of the potentiometer.

Ney offers many other precious metal alloys which bring increased reliability to electrical or electronic precision instruments. Like Paliney #7, they have excellent electrical characteristics and resist tarnish. These alloys are widely used today in precision instruments throughout industry for sliding contacts, slip rings and assemblies, commutator segments and assemblies, brush and brush holder assemblies, and for precious metal resistance wire.

The Ney Engineering Department will be glad to study your particular contact problems and make suggestions and recommendations to improve the efficiency of your electrical or electronic instruments. Call or write Ney today.

(All contacts capsule-packed in plastic)

THE J. M. NEY COMPANY • 105 ELM ST., HARTFORD 1, CONN.

Specialists in Precious Metal Metallurgy since 1812

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CASTLETON-ON-HUDSON, N. Y.

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MATERIALS ENGINEERING NEWS

poles are also plastic and are attached with metal clamps.

A test line of more than a mile of these plastics poles was subjected to weather ranging from well below zero to more than 100 F. Utility companies participating in the test are reported to agree that the poles are ready for commercial production.

Although a plastics pole will cost somewhat more than a wooden pole, the life expectancy of the plastic model ranges up to 30 yr, while a wooden pole will last only 4 yr in areas where woodpeckers are especially active.

Aluminum Companies Increase Price

Both the Aluminum Co. of America and Reynolds Metals Co. announced a 1½¢ per lb increase on basic aluminum pig and ingot and semi-finished and finished mill products. The increase brings the base price for aluminum pig to 24¢ per lb.

In explaining his company's increase, Richard S. Reynolds stated that the price increase was necessary to assure customers the expanded aluminum supplies required to meet growing demands. "The only way the supply of aluminum can be increased," he stated, "is through the construction of new producing facilities.

"The capital requirements of primary aluminum plants are extraordinarily large," Mr. Reynolds continued. "New facilities,

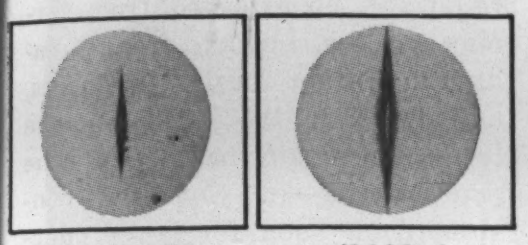
Forming Glass Chemically

Coming in June

A detailed report shows how etching of special photosensitive glass can replace costly machining and engraving operations and make possible new designs in glass products.

A composition that is almost twice as hard as the hardest steel . . . KENNAMETAL*

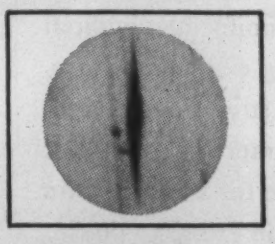
Kennametal is the registered trademark of a series of hard alloys of tungsten, tungsten-titanium, and tantalum carbides. These compositions are the *hardest* practicable metals made by man. In scratch hardness tests, these hard carbide particles are between sapphire and diamond. On the Rockwell "A" Scale, different Kennametal grades test from 90.0 to 93.0, while that of HSS 18-4-1 heat-treated steel tests a maximum of 85.0. The Knoop Test gives 2100 (K100) for Kennametal and 800 (K100) for steel.



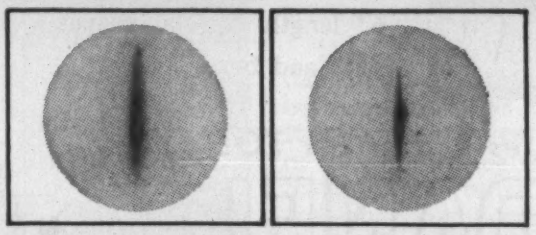
K8 Tungsten carbide — 18-4-2 Steel

Photomicrographs above show results of Knoop hardness test on Kennametal K8 (left) and HSS 18-4-2 steel (right) at 100g. Impression in the Kennametal is only about half of that on the steel.

Photomicrographs below are of Knoop tests on grains of carbide ingredient of Kennametal. Knoop test numbers (at 100g) are: tungsten carbide, 1900; tungsten-titanium carbide, 2200; titanium carbide, 2500. These tests show those carbides are from two to three times as hard as steel in the absolute scale of Kgs per square mm of area of impression.

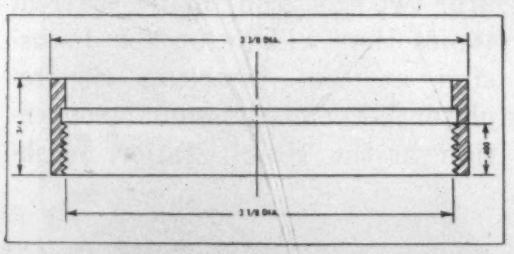


Tungsten carbide

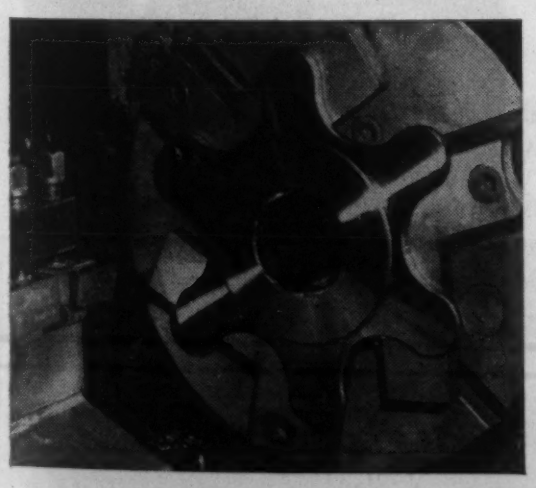


Tungsten-titanium carbide — Titanium carbide

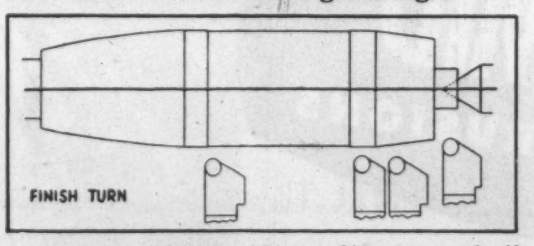
Extreme Hardness of KENNAMETAL Utilized by Designers



A West Coast manufacturer switched to solid Kennametal tungsten-titanium carbide tools for internal threading of stainless steel rings, jumped production from 35 to 40 pieces between grinds to 80 to 100 pieces with Kennametal. And the latter showed no cratering and only slight edge wear requiring only light grinding.



A manufacturer of aircraft landing gears uses the hardest grade of Kennametal cutting edges for interrupted cutting of SAE-4340 steel (220,000 psi tensile strength), at 1½ times greater speeds and with over 10 times longer tool life. Both sides of 54 pieces are rough cut and finish cut between grindings.



2400 to 3600 (depending on shell hardness) 90 mm shells are finished-turned using the hardest grade Kennametal before regrinding is required.

Perhaps KENNAMETAL's Extreme Hardness Can Help You, Too

Together with absolute hardness goes surprisingly greater resistance to wear and deformation. It is vital to innumerable industrial applications. Perhaps it is the characteristic you need to get YOUR idea off the drawing board and into production. It is worth investigating. Write to KENNAMETAL INC., Latrobe, Pennsylvania, and ask for Booklet B-111.

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at the Design Engineering Exposition

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Convention Hall
Philadelphia, Pa.

Come in and visit us while you are in Philadelphia. See "live" demonstrations that prove the many outstanding characteristics of Kennametal and Kentanium (the titanium carbide for application at 1800° F and above). See such demonstrations as:

- The Torque Test
- The Hardness Test
- The Deflection Test
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Inspect dozens of sample machine and processing equipment parts made from Kennametal and Kentanium . . . typical applications being used in practically every industry. Our engineers will be glad to talk over any of your problems and advise how you may use these hard, strong metals to advantage.

B-5926

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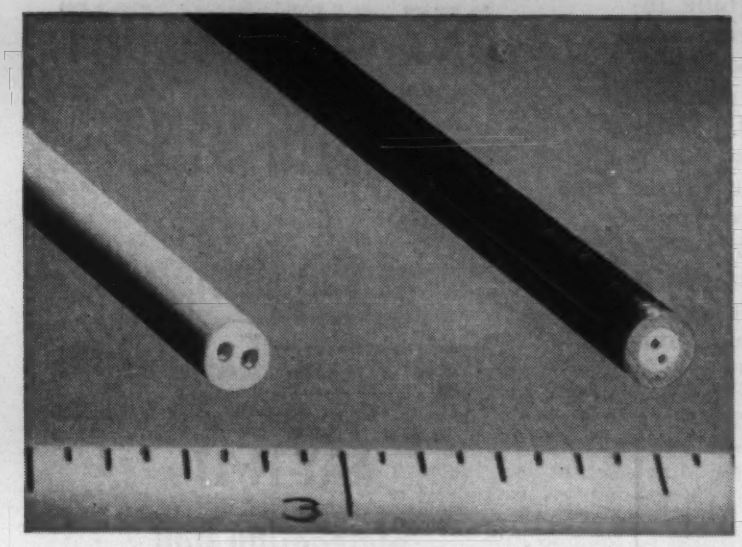
McDANEL

CRUSHABLE ALUMINA INSULATION FOR SWAGED THERMOCOUPLE TUBING



● **McDanel Crushable Alumina Insulating Tubing** crushes readily, packs firmly and uniformly without damaging conducting wire. Quickly strung and assembled. Competitively priced! Available for standard wire gauges in single, double and multiple bores. 1" to 6" length. Special shapes, sizes and bores available.

Write for samples and prices TODAY!

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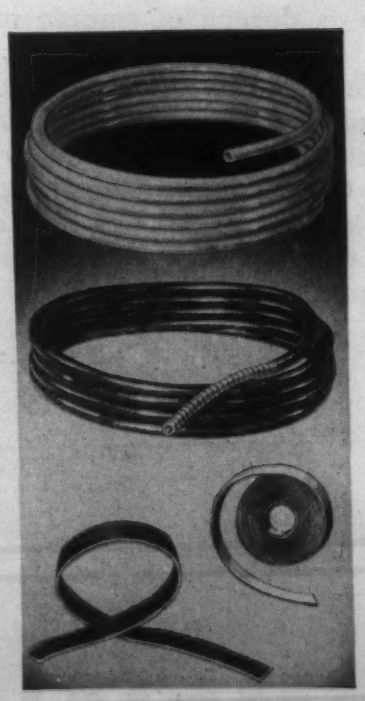

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MATERIALS ENGINEERING NEWS

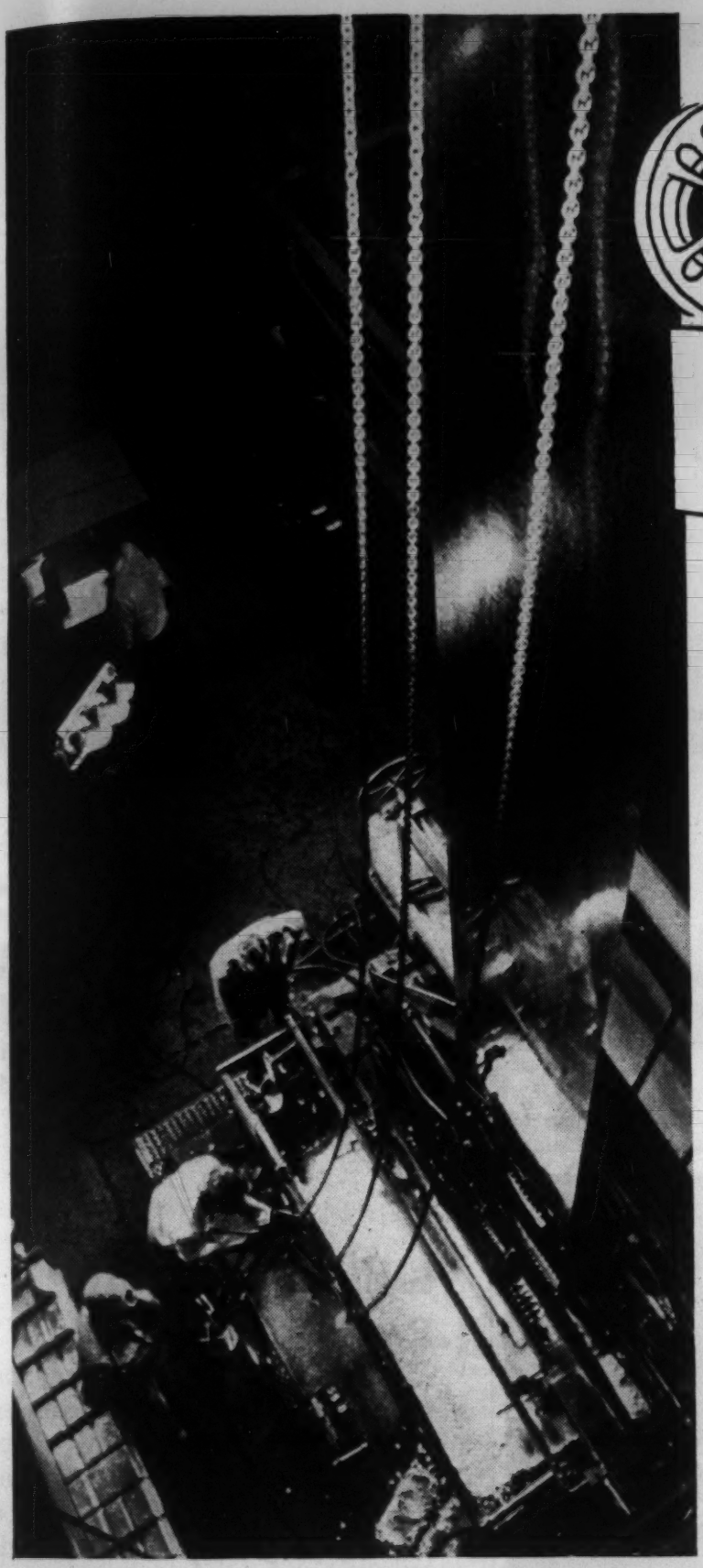
from the ore to the pig stage, today cost about $1500 per ton of capacity. This is five times the capital required per ton of integrated steel capacity."

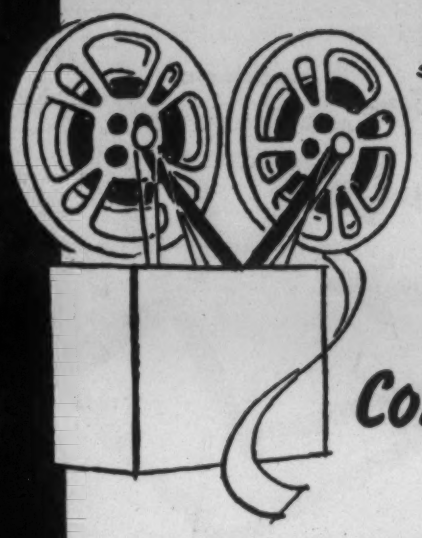
He pointed out that all available domestic primary plants are operating at capacity, and little relief can be expected from foreign sources. Imports from Canadian and other foreign producers, down 17% in 1955, will continue to be uncertain because of the prior option of European consumers on such foreign production.

Electroplaters To Meet Next Month in Capital

Hard chromium plating of titanium alloys and the adhesion of electroplated coatings to titanium are two of the many current topics that will be up for discussion at the American Electroplaters' Society's annual convention in the Hotel Statler, Wash-

Movies of the inside of aluminum pipe are used by General Electric Co. to check damage caused by uranium fuel in chain-reaction reactors. The long telescope attached to the movie camera is equipped with a wide-angle (120 deg) lens. As it moves through the tube, the telescope projects a traveling image of the tube interior on the movie film. Any damage to the tube is clearly visible when the film is projected on a screen.





SEE! HEAR!

how "Zinc Controls Corrosion"

Corrosion turns many thousands of tons of useful steel to scrap every single year. How this destructive action of the elements on steel can be delayed, minimized and controlled – thus avoiding mounting replacement and maintenance costs – is the subject of a new 16 mm. color and sound movie just released by the *American Zinc Institute*. In its 35 minutes of running time, "Zinc Controls Corrosion" presents a colorful demonstration of the general mechanism of corrosion as well as how zinc controls it.

The film uses the techniques of animation to show that, fundamentally, corrosion is the result of electrochemical action between dissimilar metals or different areas of the same metal. It explains how a galvanic cell is set up between dissimilar areas, or metals, causing the destruction of one of them and the protection of the other. While zinc has a high degree of corrosion resistance, and forms an effective and durable barrier between the steel and the elements, the film graphically illustrates that it is the sacrificial property of zinc in the presence of iron which is the key to the excellent protection which it affords vulnerable iron and steel products. Since the type of structure or product into which the steel is to go, and the kind of corrosive environment encountered, dictates the method of using zinc as a protective metal, the film also shows how steel is coated with zinc by means of galvanizing, electrogalvanizing, spraying, painting, metallizing, sherardizing, and how it is protected cathodically by zinc anodes.

Last, but not least, "Zinc Controls Corrosion" provides a fascinating insight relative to the many reasons why (a) nearly one-half of all the zinc consumed annually in the U.S. is used for the protection of iron and steel products and (b) that no program aimed at corrosion control can be fully effective without considering zinc – the protective metal.

ST. JOSEPH LEAD CO., 250 Park Ave., New York 17

above: *Exit section of continuous galvanizing line. The sheet steel emerges from zinc melting pot.*

right: *This scene from the film shows the galvanizing of hot water tanks in a bath of molten zinc.*

How to book "ZINC CONTROLS CORROSION"

The film is available for showing – at no charge – before agricultural, industrial, technical and educational groups. Prints can be borrowed from the *American Zinc Institute, Inc.*, 60 East 42nd St., New York 17, N. Y. Booking forms can be had on request.

HIGH GRADE
INTERMEDIATE
PRIME WESTERN
ST. JOE *electrothermic* **ZINC**

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BEDEVIL COMPETITION . . . You'll show them no mercy when you use some of the profitable, new ideas, developments, applications you see at the NATIONAL PLASTICS EXPOSITION. It's at New York's new Coliseum, June 11-15. Write for your tickets, now. But since there are no general public admissions, please make requests on business letterhead.

Plastics shaping tomorrow's products

at the new New York Coliseum

7th National Plastics Exposition sponsored by:

The Society of the Plastics Industry, Inc., 250 Park Avenue, New York, N. Y.

MATERIALS ENGINEERING NEWS

ington, D. C., June 18 to 21.

In all, 40 papers on electroplating, metal finishing and related fields will be presented during the convention. Subjects include: protection of molybdenum against high temperature oxidation, electro-deposits at elevated temperatures, latest progress on accelerated corrosion tests for the performance of plated coatings, chromium plating of gun bores, overlay plating of steel backaluminum lined sleeve bearings, improved techniques for electroless nickel plating on nonconductors, and a new organo-aluminum chloride bath for deposition of aluminum.

Program for the convention was drawn up by Abner Brenner, of the National Bureau of Standards.

Explore Creativity, Product Design

Proceeding on the assumption that understanding and exercise will contribute to creative problem solving, Massachusetts Institute of Technology will offer a summer program in creative engineering and product design. The program will be under the direction of John E. Arnold, director of the Creative Engineering Laboratory.

Among topics to be taken up in lectures, panel discussions and case studies are: the psychology of thinking and the influence of the subconscious; organized creative techniques; inspired creativity and comprehensive design; blocks to creative activity; analysis, synthesis and evaluation; motivation and learning; and management of creative personnel. Guest lecturers from other schools and from industry will participate in the program.

(More News on p 294)

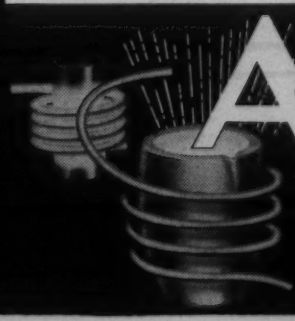
MAKE PRECISION ALLOYS IN AJAX INDUCTION FURNACES

At the Edmore, Michigan, foundry of General Electric's Carboloy Department, all the critical Alnico alloys are made in Ajax-Northrup induction furnaces.

Electromagnetic fields stir the molten metal, rapidly distributing every element of the charge throughout the melt. There's no contamination, and scrap is almost 100% recoverable. Temperature and melting speed are easily controlled by varying power to the furnace.

No wonder industry continues to choose Ajax-Northrup induction heat—as it has for forty years—for every type of melting installation. Write Ajax Electrothermic Corporation, Trenton 5, New Jersey, for details.

Associated Companies: Ajax Electric Company—Ajax Electric Furnace Co.—Ajax Engineering Corp.



AJAX NORTHRUP SINCE 1916

INDUCTION HEATING-MELTING

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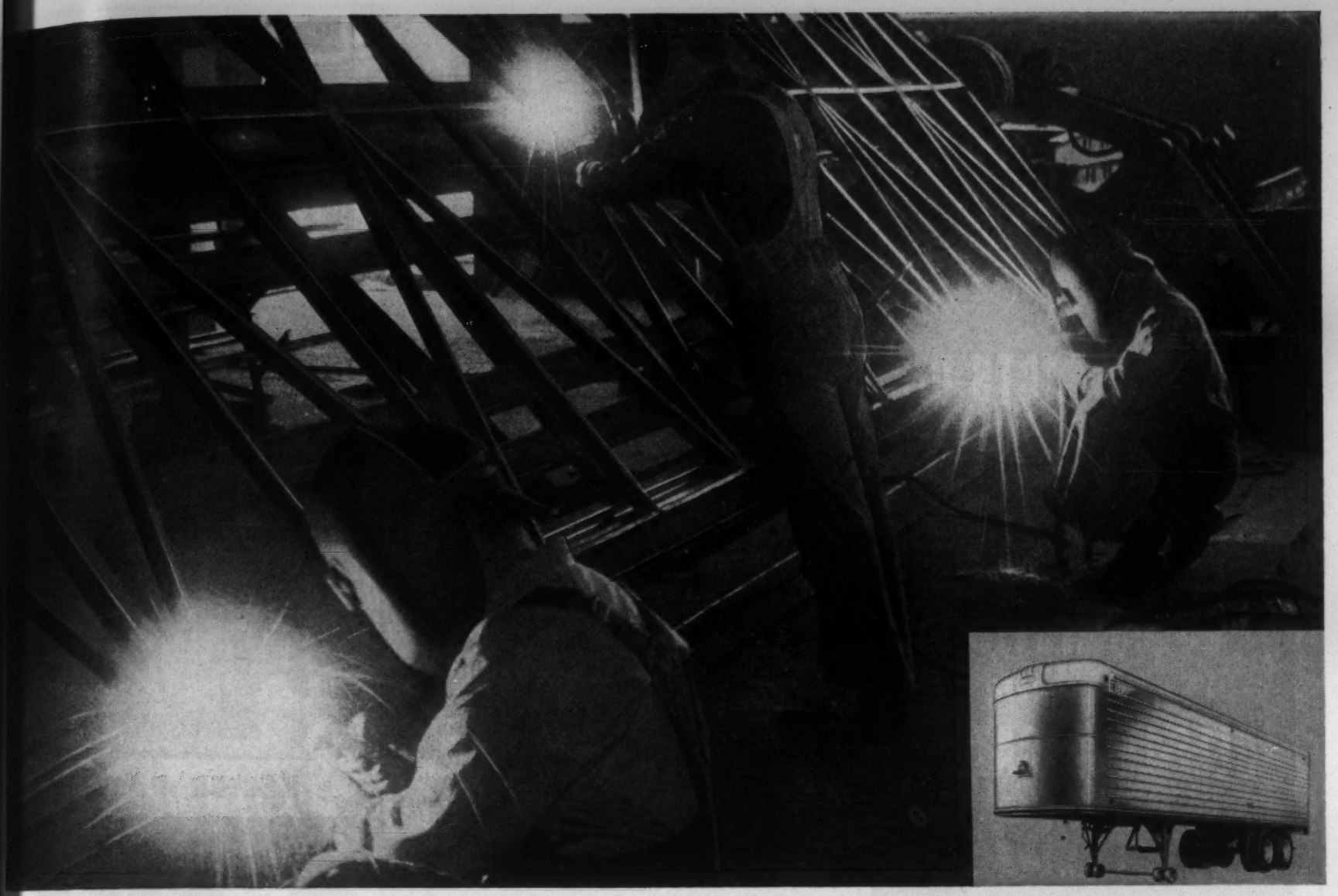

The Champion is a feather-weight van built for heavy-duty service. For extra strength Airco welding rods, Easyarc 12 and Airco 387 electrodes are used *exclusively* to join the tough-but-light tubular steel frame. Faster, more economical production was also achieved through the use of Airco Heliwelding equipment, cutting torches and accessories.

4 Airco products help put new champion on the road —lighter by one thousand pounds!

The Dorsey Trailer Company, Elba, Alabama, wanted to cut the weight of its vans by a thousand pounds — without cutting durability or strength. An aluminum and tubular steel design solved the first part of the problem. The selection of Airco products for the all-important welding job neatly took care of the rest.

From planning to production you can rely on assistance — and completely unbiased recommendations — from Airco Technical men. For Airco is the leading supplier-manufacturer of all kinds and every type of welding and flame cutting processes, their controls, supplies and accessories. Write to Airco for free literature describing Heliwelding equipment and Airco electrodes.

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In Cuba — Cuban Air Products Corporation
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Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** — industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** — carbon dioxide, liquid-solid ("DRY-ICE") • **OHIO** — medical gases and hospital equipment • **NATIONAL CARBIDE** — pipeline acetylene and calcium carbide • **COLTON** — polyvinyl acetates, alcohols, and other synthetic resins.

For more information, turn to Reader Service Card, Circle No. 381

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LOW FRICTION

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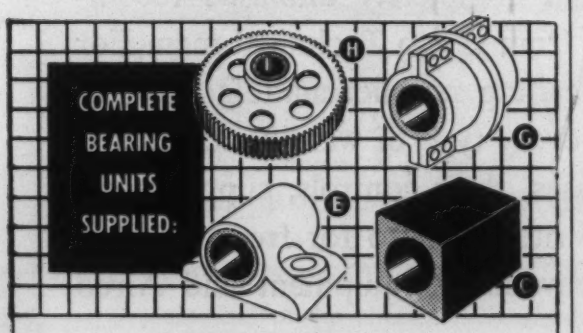
OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE OR LIQUID GASES • NON-CONTAMINATING IN FOODSTUFFS • EXCELLENT FOR CURRENT-CARRYING BEARINGS

GRAPHALLOY is widely used for self-lubricating piston rings, seal rings, thrust and friction washers, pump vanes.



BRUSHES • CONTACTS

GRAPHALLOY has high-performance electrical properties: *low electrical noise, low and constant contact drop, high current density, minimum wear!*

Brush Holders and Assemblies, Coin Silver Slip Rings and Assemblies available.

USE OUR 40 YEARS OF DESIGN EXPERIENCE!

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COMPANY
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For more information, Circle No. 461

MATERIALS ENGINEERING NEWS

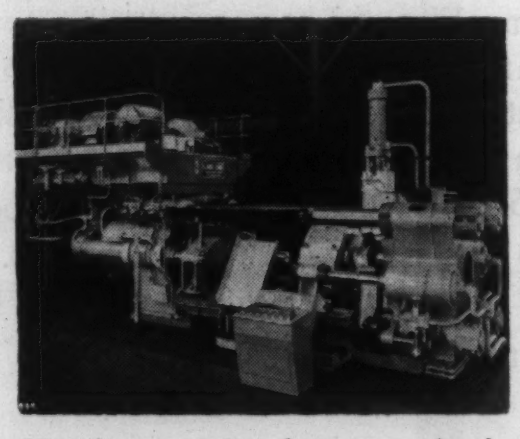
Industrial Designers Compete for Awards

The Industrial Designers' Institute has launched its sixth annual Design Award Program. Aim of the program is to give professional recognition to industrial designers for noteworthy achievements in product design and function, with emphasis on the practical use of appropriate materials.

Designs submitted as evidence for awards must be mass produced and nationally distributed. Every designer or team of designers in the field is eligible to compete. IDI defines mass production in these terms: "appropriate quantity production in any given field; for instance, six locomotives, or 100,000 radios."

Full details of the IDI award program are contained in submission forms available from Walter C. Granville, Container Corp. of America, 38 S. Dearborn St., Chicago. Forms must be postmarked by May 19.

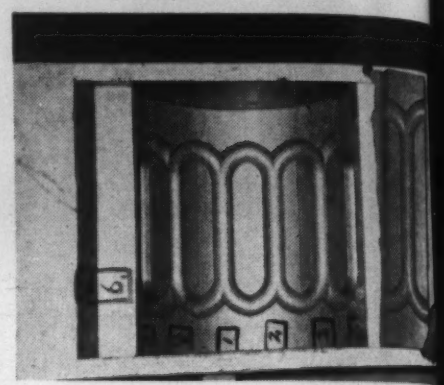
(More News on p 296)



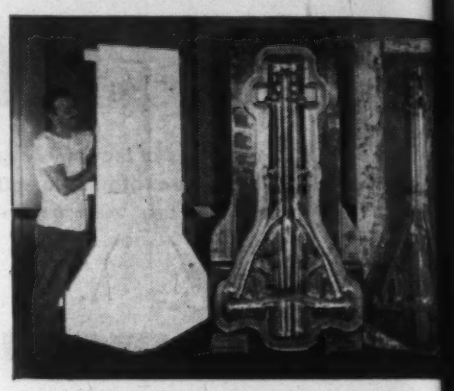
Aluminum extrusion press is the first of a series of 2300-ton self-controlled hydraulic machines to be installed by Lake Erie Engineering Corp. Capable of extruding round billets of 6 to 9 in. dia and up to 30 in. in length, as well as rectangular billets, at speeds up to 48 in. per min, this press is expected to handle 85% of all extrusion jobs. Fast approach speeds of 825 to 760 in. per min make possible a non-extrusion time of less than 20 sec.

HYSOL
Plastic Toolin
Materials . . .
• *Cut Costs*
• *Save Tim*
in these applicatio

• CORE BOXES •



• KELLER PATTERNS



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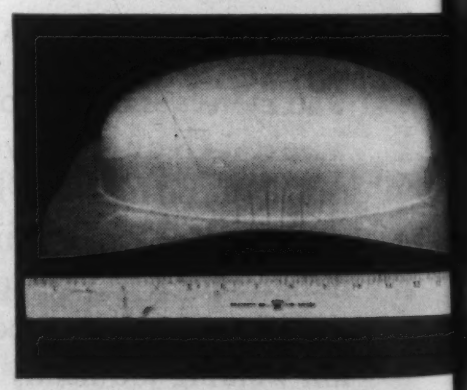

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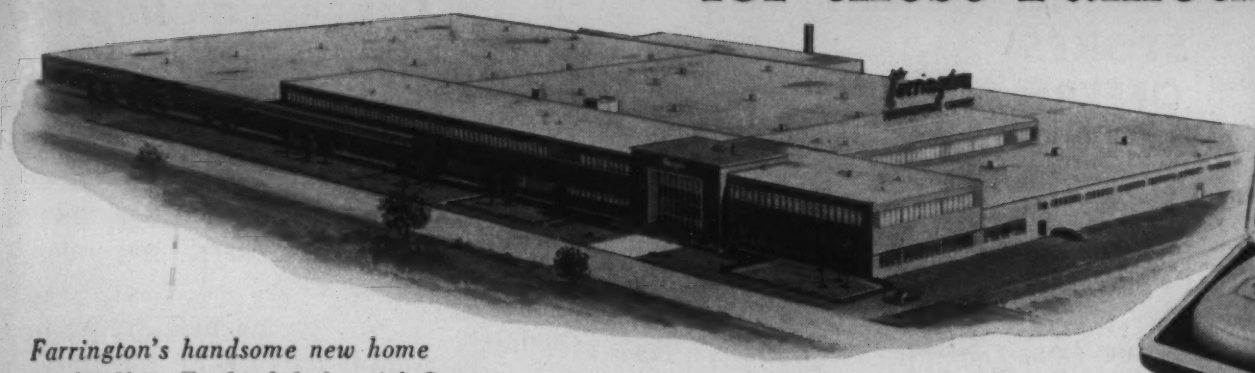

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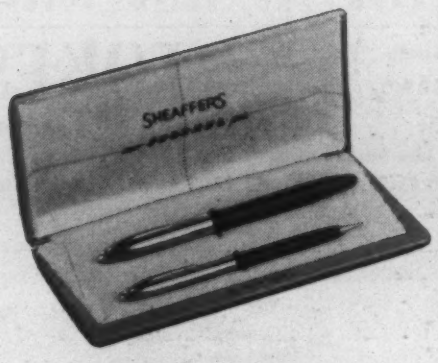
**Farrington's trade-marked name for its own simulated leather.*



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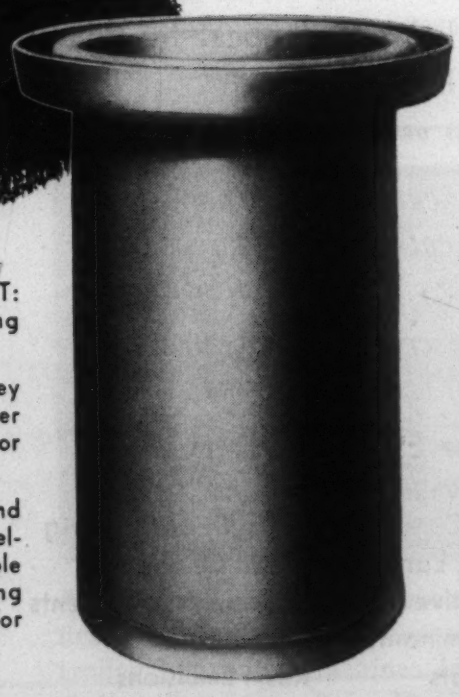

Noah Webster defines the word RETORT: (1) To answer in kind, (2) A vessel for distilling or heating.

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MATERIALS ENGINEERING NEWS

Steel Expansion Depends on Imports

With steel capacity set to rise approximately 15 million tons in the next three years, the steel industry is pushing developments in the domestic iron ore industry to offset increased dependence on imports.

Among the most important accomplishments of recent years is the commercial mining and processing of taconite and jasper to make a desirable charge for blast furnaces. There are now three major ore companies, supported by six steel companies, working in the field of taconite exploitation.

Iron ore imports totaled 26 million tons last year, an increase of 48% over 1954. The post-war trend toward greater iron ore imports, mostly from mines developed with U. S. financial and technical aid, has continued in each year save one during the past decade.

Jones & Laughlin Steel Corp.

Steel boat hulls Materials suited for the construction of boat hulls are periodically scrutinized by engineers. Reinforced plastics entered the field some time ago and seemed to be the ideal substitute for wood. Now, however, a much older material is receiving attention. In setting up standards for ruggedness and safety, the E. W. and A. P. DuPont Co. felt that hulls made of high strength low-alloy steel would best meet their service requirements.